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ABSTRACT

This essay explores how the application of the decision sciences in the interdisciplinary training, research, and development activities of model graduate professional schools of management, urban and public affairs, business, government, and regional planning might be linked to current efforts to improve leadership development and training programs in vocational education. Three major topics are treated by addressing three corresponding sets of questions. The first set of questions provides a framework for describing the mathematical and decision sciences, their contemporary influences in graduate professional education, and the issue of whether a common core of mathematical science skills exists that all practitioners should possess. The second group of questions offers a guide for examining the influences of the decision sciences in graduate professional schools traditionally associated with the managerial and social sciences. Discussion focuses on how various professions and specific institutions are approaching the development of mathematical methods and techniques as practical tools for use in everyday situations. The final group of questions explores opportunities to link the decision sciences with leadership development and training efforts in vocational education. Seven appendixes and four inserts, amounting to over one-half of the essay, are papers, articles, or supplemental material on the topic. (YLB)

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PROJECT MONOGRAPH

The Decision Sciences in Vocational Education Leadership Development Programs

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For Discussions Regarding

THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION LEADERSHIP DEVELOPMENT PROGRAMS

(A 1980 Advanced Study Center Project)

U.S. DEPARTMENT OF EDUCATION
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I. INTRODUCTION

In the past three decades the world of mathematics has evolved from a single discipline to a cluster of interactive subjects now usually termed "mathematical sciences." These sciences include, in addition to the traditional disciplines such as logic, number theory, algebra, geometry and analysis, the applied areas of, statistics, operations research, and computer science. The use of mathematical models in the behavior and social sciences has increased to such as extent that there are now distinct disciplines in mathematical economics, mathematical biology, mathematical psychology, mathematical demography and mathematical linguistics. In Mathematics Today, a set of essays commissioned in 1978 by the National Science Foundation to illustrate the development and use of mathematical concepts in current scientific research and related professional inquiries, Lynn (1978) has noted "even fields such as political science and history have not been immune to the expanding influence of mathematics: For example, the recent (and frequently controversial) introduction of statistical techniques into historical research has given rise to a new speciality termed "cliometrics" (from Clio, the muse of history)." In light of these developments, Steen suggests "there remain few areas of human intellectual activity that have not been shaped significantly by the mathematical sciences.

The contemporary influence of the mathematical sciences in model graduate professional schools of management, business,

urban affairs and administrative science is most likely to be observed in an interdisciplinary field called "decision sciences." This interdisciplinary field was created in 1968 to represent people interested in the application of mathematical and behavioral methods to problems in organizational decision systems. At that time, a group of 30 faculty members representing applied mathematics in 25 schools from across the country met in Atlanta to establish the American Institute of Decision Sciences (A.I.D.S.), a non-profit national education association to encourage interdisciplinary communication. The quarterly journal, Decision Sciences, first published by A.I.D.S. in 1970, is the major publication for the more than 4,500 academicians and practitioners now involved in the further development of the discipline.

The intent of this essay is to explore and document how the application of the decision sciences in the interdisciplinary training, research and development activities of model graduate professional schools of management, urban and public affairs, business, government, and regional planning MIGHT BE LINKED to current efforts to improve leadership development and training programs in vocational education.

We will view leadership as the influence that individuals exercise to cause movement of individuals and the organizations they comprise toward specific goals. Opportunities for leadership development programs in vocational education are many and include graduate training for positions such as

state and local directors of vocational education, research specialists and curriculum developers, deans and directors of occupational education in post-secondary institutions, teacher educators in vocational as well as career education, and planning and evaluation consultants in private organizations and agencies.[1]

The essay treats three major topics and addresses (in the order presented), three corresponding sets of questions.

The first set of questions provides a framework for describing the decision science, the first major topic.

1. What are the mathematical sciences?
2. What are the contemporary influences of the mathematical sciences in graduate profession education?
3. What are the decision sciences?
4. How have the mathematical sciences influenced the formation of the decision sciences?
5. What are the primary instructional domains of the decision sciences?
6. What are the primary research domains (issues and problem areas) addressed in the decision sciences?

The response begins by documenting the perspectives of National Academy of Sciences on the importance of research and education in the mathematical sciences in 1968, precisely the time the decision sciences first appeared in academic circles. It then moves forward through the 1970's and ends with a view from the decision sciences on the issue, is there a common core of mathematical sciences skills that all practitioners should possess?

The second group offers a guide for examining the influences of the decision sciences in graduate professional schools (or colleges) traditionally associated with the managerial and social sciences.

7. What elements of the decision sciences are likely to appear as required course work in first professional degrees (i.e., M.B.A. programs) offered in leading graduate schools of management and administration?
8. Are similar (or different) elements of the decision sciences likely to be included in the required core courses for first professional degrees (i.e., Master of Public Policy, Public Administration or Urban and Regional Planning) in model graduate schools of government, planning and public affairs?
9. What instructional strategies are used to link decision sciences with the new quantitative methods and statistics specializations offered in graduate professional schools of government, law, and public affairs.
10. From the perspective of policy research institutes and practicing policy scientists, what are the most important decision science skills to emphasize in formal training programs?
11. How have the decision sciences influenced the graduate study options in university departments of computer and information sciences?
12. How do the decision sciences differ from the information sciences?

These questions permit additional opportunities to continue the discussion of how various professions and specific institutions (primarily universities) are approaching the development of mathematical methods and techniques as practical tools that can be used in every day situations.

The final group explores opportunities to link the decision sciences with leadership development and training efforts in vocational education.

13. What are the major instructional domains (core competency areas and specializations) addressed in graduate vocational education leadership development and training programs?
14. How can the decision sciences influence educational management and administrative leadership?
15. How can the decision sciences influence curriculum and instruction?
16. How can the decision science influence leadership in the development of research skills?
17. In what ways can the decision sciences influence efforts to improve and extend the emphasis of the social and behavioral sciences in interdisciplinary vocational teacher education programs?
18. What are some specific directions for the immediate future?

The last cluster yields two opportunities for linkage. Responses to questions thirteen through seventeen identify two professional study areas that have close ties with vocational education. These are human resources development and educational technology.[2] For both areas, we will examine first professional (master's level) degree programs that have used elements of the decision sciences effectively to bridge the gap between practitioners and mathematical scientists. Responses to the last question identify alternatives that can be implemented in educational leadership development programs.

II. MATHEMATICAL SCIENCES

Mathematics can be described as the art of symbolic reasoning.[3] Mathematics is present whenever chains of manipulations of abstract symbols are used. These chains may occur in the mind of a human being, as marks on a paper, or in an electronic computer. Symbolic reasoning appears to have been first used in connection with counting. For this reason, mathematics is sometimes described (though not accurately) as the science of numbers. Actually, all symbolic reasoning can be reduced to the manipulation of whole numbers. It's precisely this fact that makes the digital computer into the universal tool it is.

This uncomplicated, but accurate, portrayal of mathematics as the art of symbolic reasoning was presented in the introductory pages of the 1968 National Academy of Sciences publication entitled The Mathematical Sciences: A Report which was designed to inform professional mathematicians and scientists, as well as scientifically oriented laymen, concerning the nature and scope of modern mathematical research and the manifold applications of mathematics in various sciences and technologies, especially the new applications influenced by the computer revolution.

To present a clear picture of the contemporary state of both research and education in mathematics and related disciplines, the National Academy of Sciences report develops three useful

perspectives. First, it offers a two-part classification to label each of the mathematical disciplines as either basic or applied.

Second, it provides a single term, Mathematical Sciences, to suggest that it is essential to maintain strong and continuous interactions between the applied and basic mathematical disciplines. On this point the report is quite specific. It prescribes "an interaction in which ideas and people must move in both directions."

Third, the report documents the use of mathematical methods in several disciplines outside the mathematical sciences to bring to the attention of professional mathematicians, scientists and scientifically informed laymen the fact that in 1968 the number of such instances was steadily increasing and, more important, that the boundary lines between mathematical sciences and "sciences that use mathematics" were often difficult to draw. In 1981, thirteen years since the report was issued, both trends are still with us.

A brief description of the classification scheme and a few comments on the related disciplines or "the sciences that use mathematics" as they are viewed in the National Academy of Sciences report follow.

Core Mathematics

The foundation of all mathematical activities is the central core of mathematics--the traditional disciplines of logic,

number theory, algebra, geometry and analysis that have been the domains of the so-called "pure mathematician." In the central core, mathematical ideas and techniques are analyzed, generalized, codified and transformed into tools of wide applicability.

Applied Mathematical Sciences

The other category in the National Academy of Sciences classification, applied mathematical sciences, has four major areas that have particularly direct and important relationships with other sciences and technologies. These are computer science, statistics, operations research and physical mathematics (usually referenced as classical applied mathematics).

Both computer science and statistics have dual sources of identity and intellectual force. In each case, only one source is mathematical. Accordingly, the N.A.S. report suggests a more accurate term, partly mathematical sciences, which they sometimes use to recognize the individual character of these fields and their strong extramathematical components.

Computer science is both mathematical and something else. It can not exist without mathematics. However, it would be utterly unproductive without the computer.

Statistics could not operate without mathematics, especially without the mathematical theory of probability. Equally, it could not exist without an appropriate theoretical framework to guide interpretations and inferences. Like computer science, statistics is both mathematical and something else.[4]

We will soon observe that three of the four applied mathematical sciences--operations research, statistics, and computer science--are essential disciplinary resources for the formation of the decision sciences. At this point, we assume most professional educators have had some experience with statistical methods, have an informed perspective on the application of the computer in some field or organizational setting, but are not likely to have had either formal training or extended first-hand experiences with operations research. Therefore a brief description of this applied mathematical science follows.

Brooks (1970) suggests that operations research can be viewed as applied decision theory. This view treats operations research as problem solving by developing mathematical models. These models are frequently designed to yield (compute) optimal solutions (maximum or minimum values) for accurately specified sets of objectives and decision rules (mathematical functions). This view also implies that operations research is intimately bound up with computer systems and with machine arithmetic.

Gupta and Cozzolino (1974) share this position, but have suggested that new operations research problems are often solved by recognizing their structural similarities to many past situations. Once these similarities are specified, existing mathematical models can be applied. Many basic operations research texts such as Miller and Lieberman (1975) and Wagner (1975) provide case studies with applications to decision problems encountered in industry, government and education.

Specialized Areas of Application

Along with the four main applied mathematical sciences, the N.A.S. report acknowledges that these are still newer "small specialized areas of application" where no self-identifying community of mathematical scientists yet exist. Among the small specialized areas detailed in the 1968 report are mathematical biology, mathematical psychology, mathematical economics and mathematical linguistics.[5]

A supplementary volume to the National Academy of Sciences (1968) report entitled The Mathematical Sciences: A Collection of Essay offers twenty-two essays that document achievements, traditions and prospects in a rich variety of special areas of application, including those listed above.[6] These twenty-two essays, plus the more recent ones offered in Steen (1978), illustrate clearly how the mathematical sciences are penetrating into fields of knowledge that have been shielded from mathematics until not long ago. Two historical perspectives on the recent dynamics in the mathematical sciences and their penetrations into the graduate studies programs of the social and behavioral sciences in the 1970's follow.

Mathematics in Finance

In the revised edition of Quantitative Techniques for Financial Analysis Valentine and Mennis (1980) have noted that when the first edition of their text was issued in 1971,

"quantitative techniques were just beginning to be applied in a major way to financial analysis."[7] The computer was available in many investment organizations; however, in 1971 it was seen primarily as "a massive number cruncher that could digest and array large bodies of numerial data the analyst used as part of the daily work."

At that time, the interest of universities in graduate courses dealing with mathematical techniques of financial analysis and investment management were growing, but had not yet had a significant impact on the investment profession.[8] Nevertheless, the Institute of Chartered Financial Analysis believed that mathematical methods and techniques would be of growing importance to practicing financial analysts. Accordingly, these mathematical techniques were established as a regular topic in the C.F.A. examination program.

To provide a useful basis for this part of the examination, the Financial Analysts Research Foundation commissioned the 1971 edition of the Valetine and Mennis text which was to emphasize the "practical application of quantitative tools to the techniques of professional financial analysis or portfolio management."

In the 1980 edition the authors provide several insights to suggest that dynamic changes were underway in the field. For example, the financial analysis literature had proliferated and was now treating many new mathematical applications. The emphasis on mathematical methods and techniques in the C.F.A.

examinations and the infusion of many mathematically-oriented analysts into the profession contributed to the significant increases in the use of the mathematical sciences in daily field operations. Moreover, they note present computer applications in investment organizations are no longer restricted to just number crunching, but are used "to analyze, to construct portfolios, and to explore and challenge many investment ideas intuitively held for years."

To get an informed perspective on an essential training question in graduate professional schools (Is there a common core of mathematical science skills that all practitioners should have?), we can examine the contents of the C.F.A. sponsored text summarized in Table One.

The first three chapters address what the N.A.S. report classification calls the central core of mathematics--the traditional disciplines of logic, algebra, geometry and analysis that are often seen solely as the analytic tools of the so-called pure mathematician.

The remaining chapters appearing in Table One draw their material from the applied mathematical sciences. The basis for chapters four through seven is statistics. For chapter eight it is linear programming, mathematical optimization and other decision-oriented mathematics from operations research. The last two chapters treat computer science issues and skills.

TABLE 1

CONTENTS OF VALENTINE AND MENNIS (1980)

Introduction: What this book is about....The growth of quantitative techniques. Problems in learning quantitative tools. Approaches used in this book. Simplifying the problem of reading quantitative material. Models: Their nature and value.

1. Notation, or the language of symbols and what they mean
2. A review of elementary algebra
3. The mathematics of compound growth explained
4. Elementary statistics
5. Probability theory, or how to treat uncertain events
6. Hypothesis testing, or how certain are patterns in the real world
7. Regression, or how to express the relations among variables
8. Portfolio models
9. The computer and programming
10. Computer usage

Based on entries in the table of contents of Jerome L. Valentine and Edmund A. Mennis, Quantitative Techniques for Financial Analysis (Revised Edition). Financial Analysts Research Foundation, 1980. Released through Richard D. Irwin, Inc. Homewood, Illinois.

Two trends deserve mentions. First, outside mathematics, the physical sciences and engineering, one seldom encounters the N.A.S. classification for the mathematical sciences. Hence, what the N.A.S. report is calling the partially mathematical sciences, statistics and computer science, are more frequently just called "quantitative methods."

This single reference for these two applied mathematical sciences is most common in the social and managerial sciences. In fact, graduate degree programs in professional schools of business, government, social and behavioral science, and education often now "advertise" majors or specializations with these titles and orientations.[9]

Appendix One elaborates for eighteen different departments, distributed over several colleges and schools at Ohio State University, a set of "selected" graduate courses that have been introduced or influenced in the 1970's by the mathematical sciences and quantitative methods movements.[10]

A second trend to be extracted from our discussion of mathematics in finance is one that will reappear in almost all graduate studies programs introduced in subsequent chapters. Here the reference is to the fact that basic mathematics, or what we have come to know as the central core of the mathematical sciences, provides essential skills for economic understanding and financial management.

In an essay entitled "Mathematics as a Tool for Economic Understanding" Schwartz (1978) refines our perspective on

the importance of mathematics to practitioners in the following way.

> Application of the cautious procedures of science and of mathematics proceeds slowly, whereas the daily affairs of hurrying mankind demand constant resoultion. Thus, where adequate knowledge and objective theory do not exist, fragmentary heaps of fact and primitive common sense reasoning will be drawn upon to fill the gap. For this reason, both personal decisions and social commitments of vast consequence often rest on doubtful and inadequate understanding. Moreover, just as a person committed to a given course may resist and resent efforts to point out irrational aspects of his behavior, so societies can resent and even repress criticism of intellectual structures, correct or not, which are regarded as essential to a social consensus and around which significant interests may have collected. In such situations, mathematics has often been used as a tool for defusing controversy and for allowing ideas running counter to some dominant doctrine to be developed in a neutral form.
>
> We will try to illustrate the way in which mathematics can contribute to our understanding of social issues. In order to do this, and specifically in order to make the point that mathematical reasoning need by no means remain remote and abstract, we will venture to reason about hard-fought areas of current controversy. This makes it all the more necessary for the reader to remember that our reasoning, like all applications of mathematics to the real world, is not at all incontrovertible, but merely represents a set of conclusions to which one can by led by assuming one particular model of reality. Any such model is but one of many possible models of differing adequacy which can lead to different, and

> sometimes diametrically conflicting deductions. Our reasoning can therefore not tell us that our conclusions concerning reality are correct, but only that they are logically possible. (270-71)

Schwartz's final statement suggests that practitioners must be conversant both with the formal rules of mathematical reasoning and their limitations if they are to properly use mathematics as a tool to understand social issues.

Mathematical Social Sciences

The Inter-university Consortium for Political and Social Research (I.C.P.S.R.) at the University of Michigan is an international resource for scientific cooperation. Its purpose is to maximize the availability of social science data and minimize the inconvenience and cost of training and studying social and historical phenomena.

Since 1962 I.C.P.S.R. has collected over 5,000 computer-readable data files on social phenomena. From its original twelve members interested mainly in political science research, the membership (including almost all major United States research universities) has grown to more than 240 institutions sharing the world's largest collection of computer-readable data in all fields of social sciences.

The I.C.P.S.R. Training Program in Theory and Technology of Social Research serves consortium member colleges and universities by offering a comprehensive continuing education program of studies in research design, statistics, data

analysis, and social methodology. In general, emphasis in the training program focuses on courses and subjects which are not normally an integral part of the curricula of member institutions. This includes several courses that, to use the N.A.S. study reference, confuse attempts to draw the boundary lines between the "mathematical sciences" and "sciences that use mathematics." For this reason, I.C.P.S.R. offerings frequently take on the convenient descriptor "Mathematical Social Sciences." Table Two provides an overview of these mathematical social science offerings and links each course with an instructional strategy. Appendix Six contains descriptions for each course entry in Table Two.[11]

The I.C.P.S R. bulletins suggest that their training program's instructional environment differs from that of all but a few statistics departments in two important respects. First, mathematical methods are studied within the broader context of substantive social science research. Second, almost all instruction is coordinated with and reinforced by active participatory data analytic experiences.

An overview of the historical development and responses of I.C.P.S.R. to the social and behavioral scientists' need for continiung education in the mathematical sciences from the early 1960's forward follows.

Early in the 1960's quantitative empirical social research in I.C.P.S.R. was essentially equivalent to basic survey research and innovative strategies for manipulating data.[12]

TABLE 2

I.C.P.S.R. 1980 TRAINING PROGRAM

Track I: Developing Quantitative Skills

- Elementary Mathematics for Social Scientists (lecture)
- Introduction to Computing (workshop)
- Introduction to Statistics and Data Analysis (lecture/workshop)

Track II: Toward Structured Data Analysis Projects

- Critiques of Social Research (lecture)
- Data Analysis and Public Policy (lecture)
- Dynamic Analysis (lecture)
- Dynamic Models of Political Economy (lecture)
- Evaluation Research Methodology (lecture)
- Formal Theories of Social Scientists (lecture)
- Mathematics for Social Scientists (lecture)
- Applied Multivariate Analysis (lecture/workshop)
- Applied Nonparametric Analysis (lecture/workshop)
- Experimental Studies of Social Phenomena (lecture/workshop)
- Introduction to Linear Models (lecture/workshop)
- Intermediate Linear Models (lecture/workshop)
- Introduction to statistic and Data Analysis II (lecture/workshop)
- Multi-Level Analysis (lecture/workshop)

Track III(a): Frontiers of Social Methodology

- Advanced Linear Models (lecture/workshop)
- Causal Models (lecture/workshop)
- Discrete Multivariate Analysis (lecture.workshop)
- Exploratory Data Analysis (lecture/workshop)
- Models with Unmeasured Variables (lecture/workshop)
- Multivariate Dimensional Analysis (lecture/workshop)
- Time Series Analysis (lecture/workshop)

TABLE 2 (con't)

I.C.P.S.R. 1980 TRAINING PROGRAM

Track III(b): Methods of Analysis in Particular Substantive Areas

- Asian American Research Methods (workshop)
- Data Processing and Data Management in the Criminal Justice Field (workshop)
- Empirical Research Issues on Aging (seminar)
- Quantitative Analysis of Crime and Crimimal Justice (lecture/workshop)
- Quantitative Historical Analysis I (lecture/workshop)
- Quantitative Historical Analysis II (lecture/workshop)

Track III(c): Common Concerns of Computing Specialists and Data Librarians

- Database Management for Complex Data Sets (workshop)
- Data Management, Library Control, and Computer Readable Information (workshop)
- Introduction to computing with SPSS (workshop)
- Small Computer System Software and Hardware (workshop)

Source: Inter-University Consortium for Political and Social Research in the Theory and Technology of Social Research. Institute for Social Research, University of Michigan.

Late in the 1960's some leading universities had employed faculty with strong substantive interests in social science to teach graduate courses in research methods, survey research, elementary statistics and, in rare instances, data analysis. Many students who were introduced to mathematical social sciences in those days continued to expand their study of statistics and social methodology in psychometric and econometric methods or in mathematics and statistics departments.

In the early 1970's three trends, the interest of many research scholars in the so-called "behavioral revolution," the growing number of data archives placed before social scientists for secondary analysis, and the recognition (especially among younger scholars) of the importance of developing computing and data analysis skills, all contributed to expanding interest of social and behavioral scientists in the basic and applied mathematical sciences.

The I.C.P.S.R. responded to these trends by expanding its data archives and extending its training efforts for college and university faculty and non-academic research scholars to include a core of courses in elementary research methods and survey research and a more advanced schedule of lectures and workshops in which specialized analytic techniques were introduced. These training programs resemble those now in Track I and Track II of Table Two. While these programs emphasized statistical analyses, care was taken to

present these analyses within the contest of understanding substantive social phenomena.

Social research in the 1970's has been distinguished by a more advanced computer hardware, an extensive array of software (some of which was developed for social sciences), an expanded distribution of faculty with interests in social methodology and readily available sources of data.

The I.C.P.S.R. training program's took many forms. Lecture/workshops focusing on recent technical advances of applied multivariate analysis were introduced to provide faculty and graduate students from institutions which already had extensive methodology offerings an opportunity to remain with those on the cutting edge. Course options in Track III(a) of Table Two are of this variety.

Workshops emphasizing policy analyses rather than quantitative analyses--were added to the curriculum to enable college and university personnel and research scientists to develop research skills that have special bearing on specific substantive problems. These workshops appear in Track III(b) of Table Two. To increase their impacts, some workshops were organized around a "data confrontation" format, an instructional strategy that will reappear in subsequent descriptions of the mathematical and decision sciences in public policy programs.

Courses that focus on the technology of social research, including computing, data management, and data librarian

methodology, were developed. These training options appear in Track III(c) of Table Two.

In August 1980 the Survey Research Center, another organizational unit of the University of Michigan's Institute of Social Research, completed its Thirty-Third Annual Summer Institute on Survey Research Techniques. Highlights of this annual institute always include the formal sampling theory courses and the corresponding workshops on which participants focus on actual probability sampling designs and plans from surveys completed around the world.

To get a second opinion on an essential training question in graduate professional schools (Is there a common core of mathematical science skills that all practitioners should have?), we can quickly review the contents in Table Two and the more detailed information in Appendix Six.

The three Track I introductory courses in mathematics, computing and statistical methods are the core skills for the I.C.P.S.R. program. They are expected to introduce prerequisite skills for Track II lecture/workshops in either Introduction to Statistics and Data Analysis II or Introduction to Linear Models. More important, however, the three Track I courses constitute the minimum background for those who expect to participate in Track III(b), a group of instructional units emphasizing the application of quantitave methods of analysis in particular substantive areas, rather than emphasizing research methodology itself.

These common core skill resemble those prescribed for the C.F.A. practitioners. The level and content in mathematics, statistics and computing are similar. One significant difference is that the I.C.P.S.R. participants are not introduced to any of the decision-oriented mathematical methods of operations research. You may recall that the chapter on portfolio analysis in the basic text for C.F.A. practitioners links operations research tools with financial analysis and investment management.

Departments of Mathematical Sciences

It is safe to assume that university departments of mathematical sciences or, in a few instances, mathematical systems, are most often found in teaching rather than research universities. Established research universities almost always maintains separate departments for applied mathematical sciences such as statistics, operations research and computer science. In the research university, pure mathematics, the central core of the mathematical sciences, also enjoys separate departmental status.

For example, this organizational arrangement appears at The Ohio State University. Mathematics and statistics are separate departments in the College of Mathematical and Physical Sciences. Computer science resides in the Department of Computer and Information Sciences. Operations research is an integral part of the Department of Industrial and Systems Engineering. Both departments are members of the College of Engineering.

This organizational arrangement contributes to a second trend, a prevailing tendency in other research university departments to develop their own specialized graduate courses that apply the mathematical sciences to specific interests of their disciplines. Evidence for this trend at Ohio State appears in the Appendix One list of specialized mathematical methods courses.[13]

These departmental trends often parallel, but on a smaller scale, the efforts of the I.C.P.S.R. over the years to develop and study mathematical methods within the broader context of a substantive domain and to collect relevant computer-readable datasets that can be used in instruction to reinforce methods skills.

Teaching universities, on the other hand, frequently have all of the central core and applied mathematical sciences located in a single department.[14] This consolidation is most likely in teaching universities who have recently initiated or significantly extended their graduate studies programs.

The single department arrangement is illustrated in Appendix Seven, a description of the Sangamon State University Department of Mathematical Systems. As the public affairs university in the Illinois state system of higher education, the mandate of the university is to address public affairs within the framework of a liberal arts curriculum and to stress practical experience, professional development and innovative teaching.

The Mathematical Systems graduate program has four concentrations, mathematics, statistics, computer science and operation research/systems analysis. Students may pursue a Master of Arts in Mathematics, M.A. in Statistics, M.A. in Computer Science or, in the operations research concentration, M.A. in public systems analysis or M.A. in Operations Research.

The mathematical systems program has a well defined inventory of service courses in the applied mathematical sciences to accommodate other public affairs graduate programs such as educational administration, public affairs reporting, health services administration, legal studies public administration and community services. These range from courses dealing with applied statistics, attempting to reduce anxiety about mathematics, structuring math games, to a special probability sampling theory course for interpreting this domain of statistical methods for prospective public sector accounting and auditing specialist. These diversified offerings illustrate the tendency in teaching universities for mathematical sciences departments to develop specialized courses for other departments, a trend that stands in direct opposition to those suggested for research universities. Later we will explore the implications of this distinction. We now turn to the decision sciences, an interdisciplinary professional studies field that appears to capture some of the perspectives and trends presented here for the mathematical sciences and "the sciences that use mathematics."

III. DECISION SCIENCES

The joint influence of the mathematical sciences and the mathematical social sciences in leading graduate professional schools of management business, urban affairs and administrative science is most likely to be observed in a new interdisciplinary field called "decision sciences." This interdisciplinary field was created in 1968 to represent people interested in the application of mathematical and behavioral methods to problems in organizational decision systems.

The Emerging Decision Sciences

Although certain mathematical models have become extremely useful for specific applications, conventional graduate programs in many instances still do little to provide systematic tools for addressing a wide array of organizational problems.[15] In the emerging decision sciences, however, mathematical models and computer systems are presented as logical extensions of problem-solving thought. Many decision sciences programs, such as the original master of decision science (M.D.S.) program initiated in 1969 at Georgia State University, now believe an essential objective of the decision sciences curriculum is to develop "hands on" skills in the area of minicomputer decision models and management information.[16]

A central focus of the beginning graduate programs in decision science at Georgia State University and The University of Pennsylvania is the preparation of general administrators and managers who can master the decision-aiding tools associated with advanced information processing equipment.

Our examination of the decision sciences moves in two directions. First, we will review the curriculum guidelines developed by the American Institute of Decision Sciences (A.I.D.S.). Second, we will examine the research and graduate study programs in the Wharton School Department of Decision Sciences. Both directions provide opportunities to observe the importance and integration of the mathematical, social and behavioral sciences in this emerging field.

Disciplines and Skills

Statements provided in Guidelines for the Decision Sciences Curriculum, a 1976 report prepared by the Curriculum Development Committee of A.I.D.S., are the current positions put forth for the design of university-based instructional programs.[17] Their widely accepted description for decision science follows.

DECISION SCIENCES UTILIZES MATHEMATICAL STATISTICAL, BEHAVIORAL AND COMPUTER SCIENCES TO MODEL DECISION PROCESSES IN GOAL SEEKING (BUT NOT NECESSARILY PROFIT-MAKING) ORGANIZATION. IT IS A SCIENTIFIC APPROACH TO THE RESOLUTION OF COMPLEX ORGANIZATIONAL PROBLEMS THAT CUTS ACROSS TRADITIONAL DISCIPLINARY BOUNDARIES AND SYNTHESIZES RELEVANT PORTIONS OF EACH TO DEVELOP USEFUL MODELS OF DECISIONS.

Decision Sciences programs are similar to traditional Master of Business Administration programs in their interdisciplinary focus. The A.I.D.S. Committee suggests that they differ

from them primarily in the extent to which they utilize mathematical relationships and the power of the computer to model decision processes and to organize information systematically in order to understand the complex relationships which exist in most real-world situations. The committee reports "In its use of the mathematics, it strives for usefulness rather than elegance for its own sake. In its use of the behavioral sciences, it seeks to make explicit the multi-faced relationships which influence or even determine the nature of the problem to be solved."

THE GOAL OF THE DECISION SCIENCES PROGRAM IS TO PREPARE STUDENTS WHO CAN PARTICIPATE IN MANAGEMENT AS MODELERS OF DECISION PROCESSES AND ORGANIZERS OF INFORMATION. THE SPECIFIC CONTENT OF THE PROGRAM IS LESS IMPORTANT THAN ITS PHILOSOPHY AND THE WAY ITS PARTS ARE INTEGRATED TO ACHIEVE THE PHILOSOPHY.

Much like the I.C.P.S R. approach to instruction where mathematical models are studied within the broader context of substantive social science research, A.I.D.S. guidelines claim decision science programs must include a considerable amount of theory and method, but must also design the opportunity to apply them to real-world problems. On the point, the guidelines are clear, "organizations are the laboratories where these skills are developed." Hence, the context of substantive interest is the daily world of the practitioner.

General requirements for development of decision science programs are offered in Table Three. These requirements begin with formal mathematics and move in the direction of skills for problem formulation and resolution.[18]

TABLE 3

GENERAL REQUIREMENTS FOR DECISION SCIENCE PROGRAMS

1. Provide mathematical competence in matrix algebra and symbolic logic, plus differential and integral calculus. Additional training in differential equations, calculus, and linear algebra would be desirable, but not mandatory.

2. Provide a thorough grasp of the concepts of probability and statistics such that they can be used in the design of decision models and analysis of data.

3. Emphasize general concepts, intuitive proofs, and applications for a broad range of models rather than rigorous theoretical development of a few. However, there should be sufficient theoretical rigor to permit formation of meaningful judgments on the likely effects of violating assumptions to fit real-world problems.

4. Provide meaningful coverage of useful modeling approaches including financial economic and behavioral models (e.g., models of cognitive processes, group structure and processes, and organizational structures and processes) as well as the standard quantitative models such as linear programming, decision theory, queueing, and simulation. Models should be viewed as frames of reference around which a system can be formed rather than unrealistic, oversimplified problems. Students should be exposed to a broad range of realistic model applications.

5. Conform to the American Association of Collegiate Schools of Business (AACSB) guidelines for training in business administration. (Some modifications of this requirement might be possible if the program is not housed within a college of business, but even then it should contain adequate training in information systems, planning, and control.)

6. Include meaningful exposure to the resolution of complex, real-world problems which cross traditional functional boundaries as part of all coursework. As a practical matter, some of the exposure may have to come in the form of cases and games.

7. Provide for some degree of specialization in one of the functional fields of business. (If the program is not housed in a college of business, specialization might be in a field within the host college.)

8. Provide a thorough <u>understanding of</u>, and ability to <u>communicate with</u> people in order to facilitate problem formulation and implementation of proposed solutions.

Based on American Institute for Decision Sciences Curriculum Development Committee. <u>Guidelines for Decision Sciences Curriculum</u>. A.I.D.S., 1976.

Before we turn to an interpretation of these guidelines in the decision sciences program at the Wharton School, a final perspective from the A.I.D.S. Committee report to their academic colleagues deserves review.

A decision science program should help graduates become effective modelers of decision processes in the broadest sense. They must possess the ability to take the usual mixture of accurate, inaccurate, missing and duplicate data and develop information which relates to the organizations objectives. While they will make use of mathematical models when relevant, they must know when to use less-sophisticated information decision systems. They will be aware that since decisions are made ultimately by people, their success in getting programs accepted will depend on effective documentation and many human factors.

In Decision Sciences at the Wharton School, one finds the following statement "Spectacular growth in the use of computer-based information systems and quantitative approaches to managerial decision-making has created a need both for managers who can properly use sophisticated decision-aiding systems and for research toward understanding and designs such systems. The Department of Decision Sciences at the Wharton School was founded in 1974 in response to these needs."[19]

At present this University of Pennsylvania department has degree programs at the BS, MBA, and Ph.D. levels, as well as

in several areas of executive education. Two of these are the department's commitment to provide decision science courses in the Wharton Executive MBA program and a four-week comprehensive course in information systems offered annually to a select group of managers.

Research Domains

Research in decision sciences includes and attempts to integrate a diverse set of related fields that have developed over the past two decades primarily in schools of business and management. These are traditional management science focusing on planning, scheduling and inventory control; the study of information systems, particularly database management, decision support systems and office automation; and the psychology of decision processes, with a focus on risk and uncertainty. "Marked by this diversity, departmental research as a unifying theme: understanding and improving decision-making."

The three fields, traditional management science (with its focus on the use of mathematical models), information systems (with its emphasis on the potential of advanced information processing equipment) and the psychology of decision processes (with its concentration on the theories and models of the social and behavioral sciences) use the "unifying theme" to produce the four research domains elaborated in Table Four.

TABLE 4 .

RESEARCH DOMAINS IN THE DECISION SCIENCES

Research in

1. Decision Process provides new knowledge about how to design better man-machine interfaces and how to adapt problem-solving methods to the needs of the decision maker. Research in this domain has been concerned with the way individuals and groups collect and use information, and how their actions are thereby affected. Both developmental and experimental research methods are used.
2. Management Information Systems investigates how best to provide information for organizational decision making. Research in this domain has been concentrated in the areas of data base management, office automation, activity systems and computer networks.
3. Management Science studies formal models and methods for structuring and solving certain classes of managerial problems. Research in management science domain has been concerned with the development of quantitative approaches for aiding managerial decision making.
4. Decision Support Systems carries the promise of integrating these three domains through interactive computer-based models. Research in this domain has been concerned with creating a meaningful dialogue between designers and users of interactive computer-based systems. Two projects underway are concerned with how to design decision-aiding tools for operational and policy-related questions.

Based on information found in Decision Sciences at the Wharton School, a University of Pennsylvania release detailing the academic affairs of the Department of Decision Sciences.

Instructional Domains

At both the undergraduate and the graduate levels, the Department of Decision Sciences offers an introductory core, plus higher-level specialized courses in decision processes, information systems and operations management. These instructional domains are almost identical to the first three research domains detailed in Table Four.

The departmental credo is straightforward and speaks directly to those who wish to link training in academic environments (graduate professions levels for our purposes) to performance in the field. It states "the Department believes that the understanding of information systems, modeling and decision processes will improve the performance of managers. We do not study or teach technology for its own sake. We believe that the combination of newly developed techniques with traditional expertise in accounting, finance, and management will prove powerful and effective."

A brief overview of the graduate level introductory core courses follows.

ORGANIZATIONAL AND ECONOMIC IMPLICATIONS OF INFORMATION SYSTEMS. Focuses on the role of the information system in governing the behavior of an organization. Topics include planning and control systems, the role of analytical and simulation models in decision making, the economics of information, implementation of an integrated system, and the organizational and social implications of information technology.

MANAGEMENT DECISION ANALYSIS. A quantitative methods course oriented around case studies involving resource allocation, decision analysis, and simulation. The course is particularly appropriate for students with some quantitative background who are interested in an extensive and practical treatment of management decision-making methods. Methodologies for structuring analysis are presented for problems in both the public and private sectors. Readings and cases deal with decision problems in a variety of managerial contexts, such as banking, manufacturing, process industries, utilities, and service sector systems.

MANAGEMENT INFORMATION SYSTEMS. This course considers the computer, its history, components and architecture; the managerial use of computers for data processing, planning and decision support; and the process of systems analysis and design whereby technology is brought to bear on the problems of management.

INFORMATION SYSTEMS FOR FUNCTIONAL AREAS. Designed to enable the nonspecialist to understand information technology in order to use it more effectively. Topics include file organization and processing, data base management, integration of information systems, economic evaluation of information systems and the management of the implementation process. A major design case is used to illustrate general concepts.

DATABASE MANAGEMENT. Examines various theories of data, including the hierarchical model, the relational model, the entity-set model, and the network model. Implementation of data base management systems will be considered with a focus on the Wharton Alerting Network Database (WAND) system. The course also studies topics related to the application of data base management systems, including data base design, cost trade-offs, and the implementation of application programs.

INFORMATIONS SYSTEMS ANALYSIS AND DESIGN. A case-oriented course in systems analysis, design, and implementation. Emphasizes the need for information systems that effectively meet the current needs of an organization, are flexible and thus can meet future unanticipated requirements, and operate efficiently.

OPERATIONS PLANNING AND CONTROL. Decisions associated with the management of operations are central to organizations in the public and private sectors. This course explores alternative approaches to specific problems in the area, illustrating them with published applications and cases. Topics include inventory control, planning and allocation of capacity, and the design of distribution systems. Emphasis is on medium and long-term planning problems, and analytical, informational, and functional methods available for resolving cost/performance trade-offs in areas central to the control of operations.

MODEL-BASED INFORMATION SYSTEMS. Using the case method, this course addresses the design and implementation of those computer-based information systems which contain decision models. The purpose is to examine the ways in which information systems can be used to interface models with users and with each other and to identify the critical decisions in the life-cycles of these systems which affect their success.

FOUNDATIONS OF DECISION SYSTEMS. Examines theoretical aspects of problem solving. cognitive processes, and artificial intelligence, as well as the structure and underlying technology of model-based planning and control in organizations. Approaches are developed for the validation and performance evaluation of decision support systems.

SEMINAR IN INFORMATION SYSTEMS. Presentations by faculty and advanced students introduce research in Information Systems. Individual research projects are initiated early in the course by the students, and are subsequently presented to the class and discussed in seminar format. Student research topics have included, for example, the design of a query language for office automation, and the implementation of data base design software.

STATISTICAL CONTROL OF OPERATIONS. Decision-making for control comprises a large part of the operations manager's job. To the body of standard methods available for dealing with such problems, new techniques and technologies have been added recently which show promise for operations and management control, especially in the broader context now understood to be the domain of operations management. This course explores both the traditional and the new methods for making control decisions. Emphasis is on understanding the features and interrelationships of the methods, and on assessing their applicability in control problems, rather than on building technical skill in their use.

MATHEMATICAL PROGRAMMING. Mathematical programming problems occur in a variety of areas including the decision sciences, economics, operations research, accounting, finance, and marketing. This course is an introduction to math programming for students who would like to be intelligent and sophisticated consumers of math programming theory, but do not plan to specialize in the area. Decision topics covered include linear and nonlinear functions, continuous and discrete variables, and constrained vs. unconstrained problems.

SEMINAR IN DECISION PROCESSES. Introduces models of the decision process drawn from economics, mathematics and cognitive psychology. Topics include the analysis of decision criteria, game theory, value theory, human information processing and applications. Individual student research projects are presented and discussed in seminar format.

A more detailed description for several of these courses appears in Appendix Two. In the following chapter, which analyzes MBA programs (or similar first professional degrees) in twenty-two leading graduate schools of management and business, we will have another opportunity to examine in more detail precisely how the graduate introductory core courses in decision science are utilized in other first professional degree programs at the Wharton School.[20]

Executive MBA Program

The Wharton Executive MBA is designed to enable mid-career executives to attain a Wharton MBA while retaining job responsibilities. Like most executive degree programs, it's structured curriculum provides in-depth graduate level training which builds on a practitioner's work experience. Courses in quantitative methods, interactive programming and management information systems are the decision sciences components in this executive program.

It should be mentioned that the mathematical skills and more important, the expectations for their use, are no different for the executive MBA candidate. This means that mid-career executives whose last labor pains in mathematics occured before the "Modern Math" revolution will more likely take at least one of the noncredit offerings described in Appendix Two.

Continuing Education

The increasing complexity of organizational operations has placed growing importance on the proper use of computer-based information systems. A crucial element in their success is the systems designer, who serves as an essential link between the information user and the systems programmer.

The Department operates the Wharton information systems program, a comprehensive four-week course developed to educate selected personnel in the skills required to design, implement and evaluate advanced information systems. The course is conducted at the graduate level and approximates in content (and approach) much of the material covered in the department's sequence in formations systems.

Improved Performance

The department's credo becomes an important consideration for the movement from a focus on the "workings" of decision sciences toward exploratory efforts to link them with vocational educational leadership development programs.

In brief, the position is an understanding of information systems, mathematical modeling and decision processes will improve the performance of managers. Decision sciences are not substitutes for the development of other traditional skills. In combination with traditional expertise in accounting finance and management, decision science skills will prove powerful and effective. Practitioners taking decision science courses are better prepared for traditional management roles, for important positions as internal data base consultants or systems analysts and for careers as managerial consultants.

CHARTING

IV. MANAGEMENT AND ADMINISTRATION

Essay Question addressed is Number Seven

What elements of the decision sciences are likely to appear as required course work in first professional degrees (i.e., M.B.A programs) offered in leading graduate schools of management administration?

Response

In progress is a content analysis of the core course requirements in the M.B.A. or equivalent first profession master's degree programs in the 22 "top" graduate schools of management and business. The analysis classifies each core set of courses according to the decision science domains elaborated in Table 4 (page 33 of this monograph). Trends will be reported. For the moment the pattern in these 22 institutions appears to follow that established for the Wharton School M.B.A. described in Appendix Two.

V. URBAN AND PUBLIC AFFAIRS

Essay Question Addressed is Number Eight

Are similar (or different elements of the decision sciences likely to be included in the required first professional degrees (i.e., Master of Public Policy, Public Administration, or Urban and Regional) in model graduate schools of government, planning, and public affairs?

Response

Attached is a set of core course requirements for the basic M.A. program at the Carnegie-Mellon University School of Urban and Public Affairs. This case study provides a "representative" first professional degree program for a "top" school in the urban and public affairs category.

Using the four decision science domains in Table 4 (page 33 of this monograph) an analysis can be made and reported in the text. At this time, the reader may wish also to examine a similar M.A. program offered at the New School for Social Research. See Appendix Three.

The general trends appear to be the following:

Management Science. There are several math modeling efforts in urban and public affairs core courses. These efforts focus on public rather than corporate applications that prevail in many M.B.A. programs.

Informations Sciences. Here the focus is on government rather than corporate data bases. Course requirements and instructional strategies are similar.

Decision Processes. In public and urban affairs courses are more likely to focus on public rather than on individual managers and corporate problem solving choice and policy analysis.

There is a common set of skills for all public managers and officials. It treats both "quantitative" and "analytical" perspectives. See Appendix Four.

Model schools of management and urban affairs often merge core course requirements (including decision sciences requirements) for an entire set of first professional degrees. This is the case for the New School of Social Research programs offered in the Graduate School of Management and Urban Professions.

Carnegie-Mellon/M.S. Core Curriculum Descriptions follow.

SCHOOL OF URBAN AND PUBLIC AFFAIRS
Carnegie-Mellon University
M.S. Core Curriculum Descriptions

INTRODUCTION TO COMPUTER SCIENCE. This course covers the fundamentals of computing, from both a hardware and software point of view. Extensive exercises are required. Course covers basic concepts of flowcharting, programming languages, numerical and symbolic computation. The course concentrates on using the computer as a tool for problem solving in a time sharing environment.

FINANCIAL ACCOUNTING. This course provides the student with an understanding of how financial information for the private sector is prepared, organized and analyzed. Accounting is viewed as a component of the total information system, and an attempt is made to develop a vocabulary and set of rules for dealing effectively with this component. The first portion of the course concentrates on transaction analysis, while the latter portion concentrates on financial analysis.

GOVERNMENT ACCOUNTING. This course provides an introduction to governmental and non-profit accounting for SUPA students. The course builds on the foundations of the financial accounting course, covering such topics as fund accounting, budgeting processes and an overview of governmental forms. The course also places an emphasis on the systems approach to accounting.

METHODS AND APPLICATIONS OF OPERATIONS RESEARCH. The first seven weeks follow the self-paced linear programming module: transporation and network flow, feasible lists of activities, simplex method sensitivity analysis, duality, The remainder of the course stresses the modeling of problems in the public sector emphasizing issues in regulation and equity.

INFORMATION SYSTEMS FOR THE PUBLIC SECTOR. Focuses on applications and management of information systems to the public sector. Data structures, the organization of large

databases, data management system design and implementation are surveyed. Computer architecture, operating systems and software development are also considered. Attention is given to issues of public sector implementation of large databases and the distribution of public knowledge.

HISTORICAL PERSPECTIVES ON URBAN PROBLEMS. This course is designed to meet the needs of SUPA for an interdisciplinary introduction to the city as a social and physical system. It emphasizes the historical and cross-cultural development of cities and the interaction between qualitatively defined forces (ideological, economic, and sociological) and an existing physical and social structure. Primary focus is on the rise of the industrial city and the development of American cities, including comparisons between American, European, and nonwestern urban areas.
The course is divided into the following units: the urban system, demography, urban ecology, mobility, urban attitudes, urban politics, social pluralisms, and visions of the future.

PHYSICAL-TECHNICAL SYSTEMS. Subject matter in the Physical-Technical Systems courses is different each year. Organized around significant problems of society, economic and political considerations. Projects involving team efforts are emphasized and generally directed toward issues of urgent current interest, and the course is normally closely coupled with some public institution which is interested in the results of the activity. The courses are usually taught jointly by faculty from within SUPA and from other departments or colleges of the University who are actively interested in the problems at issue. Each course is organized around recognition of needs, problem definition, information gathering, formulation of

alternative solutions, hypothesis testing, design and evaluation. Typical problems could be from such areas as housing, health care, land use analysis, law enforcement, environmental quality, or transportation. They have included projects such as determining cost effective strategies for control of air pollution sources during episodes of high pollution, analyzing the road management maintenance system of Allegheny County, preparation of model legislation and regulations for the control of noise, development of models for the siting of solid waste processing facilities, the use of communications as a substitute for travel and the design of integrated utility systems. Small groups work on these projects using the whole range of problem-solving techinques including the building of hardware. Problem solutions may include the design of a new institution, the preparation of plans, etc., and can also include follow-up information systems for evaluation, correction, control, and implementation. Project activity culminates with the presentation of the students' results in a formal document to the interested public or private body.

SYSTEM SYNTHESIS AND DESIGN. This course is intended to provide an opportunity for the students to gain experience and understanding in the formulation and solution of problems in the public sector. As such, it is intended both to complement the theoretical courses, as well as to integrate the facts and techniques students have learned and to enable them to put these to a practical test.

The operation of the course involves the class in the definition and solution of one or more major public problems. These problems vary from year to year, but they are drawn from such areas as provision of low-income housing, design of an urban para-transit system, development of a regional criminal

justice plan, design of a management information system for public officials, or the design of a network of community service facilities within the center city. The class examines these problems from relevant viewpoints, including the definition of system objectives, user requirements, as well as the examination of technological and procedural alternatives in designing the systems and consideration of the political problems in implementing solutions. The class project leads ultimately to one or more project reports. Organization of the class into teams handling various aspects of the problem in a typical project way, with interaction among the teams. The class is expected to design experiments, conduct inquiries and collect data, and they are also expected to use expert advice from the faculty, industry, government, or the public as the needs arise.

QUANITITATIVE METHODS OF PUBLIC MANAGEMENT. Quantitative Methods for Public Management (QMPM) is designed to fulfill the requirement of a one year, first level graduate course in statistics and data analysis for students of public policy analysis and/or public management. The course is innovative in its teaching approach and covers a diverse set of traditional and contemporary data analytic procedures. Developed at Carnegie-Mellon University's School of Urban and Public Affairs, it has been taught on an experimental basis for two years. Evaluation of student attitudes, data analytic competence and ability to apply techniques learned in the course to other areas indicates that QMPM has decided advantages over traditional approaches. A federal grant supported development of the course and many schools have now adopted the approach it pioneered.

QMPM will cover exploratory data analysis, regression, survey analysis, traditional confirmatory statistics, modes and

ORGANIZATIONAL ANALYSIS. Organizational Analysis is a semester long course broken into two minis; one prior to the internship and one immediately following the internship. Therefore the course is integrally related to the internship experience. At SUPA the internship serves as a laboratory in which the students test the hypotheses espoused in the class. The thrust of the course is designed to help the student understand what makes organizations function. Once a consensus has been evolved as to how they function, we explore the methods by which an effective manager operates within the framework of ethical and emotional constraints to accomplish his ends. In short, the course is designed to motivate students to think critically about organizational structures.

The second mini designed to help the student consider alternative strategies to accomplishing ends within an organizational context. Students are presented with current organizational problems, and are asked to develop a variety of creative solutions.

As a basic organizational strategy, the course requires competency in reading, writing and oral presentation. We use the presentation coaching system, as well as video type equipment, to aid in assuring that all students can satisfy the requirements for this basic organizational strategy. Additionally, the course has a weekly workshop, primarily directed and designed to encourage people to consider alternative ways of increasing their value to other members within the organization. All students are required to take a communications diagnostic as a means of determining level of competency.

While much of the course, including the internship, is essentially applied, it is also rooted in the research and development of organizational theory.

contingency tables. Exploratory data analysis emphasizes careful attention to the basic nature of data, their manipulation and organization, the application of robust estimation procedures for fitting models, graphics and the use of residual analysis in the evaluation of fits. Empirical data are used throughout the course to give students operational experience with policy relevant applications.

ECONOMIC PROCESSES. This one year sequence in economic analysis covers topics in micro-economics, welfare economics, cost benefit analysis and macro-economics, as well as institutional material related to planning, programming and budgeting. The first portion of the course is devoted to micro-economics and focuses on the functioning of a private enterprise economy. Special attention is given to the properties of pricing systems and to the conditions under which they will or will not operate efficiently.

Building upon the background of micro-economics we begin the study of welfare economics, and develop the tools of cost-benefit analysis in order to demonstrate their usefulness in planning and evaluating governmental programs. Special emphasis is placed on the intricacies of obtaining adequate measures of the benefits of programs, on evaluating these measures, on the problem of determining conditions under which accounting and market data are suitable indications of social costs, and upon the treatment of incommensurables. Distinct efforts are made to develop both an appreciation for the power, as well as the limitations, of this type of analysis. Large parts of the course are devoted to special studies and cases. The portion devoted to macro-economics covers such basic problems as inflation and unemployment, as well as an exploration of the available tools for managing the aggregate economy.

CHARTING

VI. QUANTITATIVE ANALYSIS AND STATISTICS

Essay Question Addressed is Nine

What instructional strategies are used to link decision sciences with new quantitative methods and statistics specializations offered in graduate professional schools of government, law, and public affairs?

Response Themes to be Developed

1. For a research university elaborate graduate quantitative analysis and statistics course, classify courses accoring to the four decision science domains in Table 4 (page 33 of this Monograph), analyze instructional trends associated with courses in each domain, and report findings in narrative or chart if appropriate. The case study in this case is The John F. Kennedy School of Government, Harvard University.
2. Repeat the exercise for a teaching university. The case study will be the Sangamon State University, a public affairs school located in Springfield, Illinois. See Appendix Seven.
3. Discuss trends for teaching statistics by case study method. (Fairley and Mosteller, 1977).
4. Discuss other instructional strategies, For example, see SETUPS in Inserts and references such as McRea and Wilde (1979), Stokey and Zeckhauser (1978) and Pool (1976).
5. Following are the Kennedy School of Government quantitative analysis and statistics courses. (M11 to M959)

M111 - ANALYSIS FOR DECISION MAKING. Surveys the use of analytic methods such as benefit-cost analysis, discounting, and mathematical modeling in public choice. Emphasizes decision analysis, a methodology for structuring one's thinking about complex choice situations in which uncertainty is a critical element. Note: Open to all students, but particularly oriented toward those in the professional schools who will need to use and understand analyses of public policies.

M113 - ANALYTIC FRAMEWORKS FOR POLICY. Develops abilities in using analytic frameworks in the formulation and assessment of public policy. A variety of analytic techniques, particularly those directed toward interactive decision problems, are considered. Emphasis is on the application of techniques to policy analysis, not on formal derivations. Students encounter case studies, methodological readings, the computer, a final exam, and a term paper that requires the development of an analytic model and application of it to a real world decision situation. Note: An understanding of intermediate-level microeconomic theory and elementary techniques of optimization and decision analysis are prerequisites.

M119 - SEMINAR ON PUBLIC AND ORGANIZATIONAL DECISION MAKING. Investigates selected topics in group, as contrasted with individual, decision making. Emphasizes problems relating to incomplete information, structure of communications, divergences of interest within the organization. Students are expected to present papers during the second term. Note: offered by the Department of Economics as Economics 2190hf.

M120 - INTERACTIVE DECISION ANALYSIS. Students will participate as players in a series of experimental games designed to illustrate various strategic, interactive, decision problems. Through role-playing exercises, students will be led to

"discover" some of the basic notions of the theory of games. Some topics that will be covered are competitive analysis, auctions, competitive bidding, competitive contracting, distributive and integrative bargaining, environmental mediation, principles of arbitration, fair division, coalition analysis. Note: Open to all students in the Public Policy program and other students who have had an introductory course in decision analysis, or who are familiar with this material through self-study. M111 can serve as a co-requisite.

M123 - LARGE-SCALE MODELS FOR POLICY ANALYSIS. Surveys the main theory and computational approaches found in successful applications of large-scale planning models. Topics include input-output systems, linear and nonlinear programming models, consumption and production models, and decentralized procedures for planning. Attention will be given to problem formulation, methodological issues, and specific applications. The second half of these lectures will be devoted to the issues that arise in combining models. The construction of a model for policy analysis sometimes uses existing submodels to describe certain sectors of the economy. Principles to guide the combining of models with a consistent framework will be formulated. Applications of these principles to energy-economy models and models for development planning will form the final topic of this course. Note: Calculus, elements of linear algebra, and microeconomics are prerequisites.

M221 - MICROECONOMICS AND PUBLIC POLICY (Micro I). Introduces microeconomic theory to students who have had little previous exposure to economics. Designed to convey basic tools for analysis of public policy questions and for more advanced economics courses. Note: Students seeking a somewhat more advanced and more quantitative course should investigate M222.

M222 - MICROECONOMICS AND PUBLIC POLICY (Micro II). Introduces microeconomic theory to non-economics graduate students with

little previous exposure to economics. Designed to convey basic tools for analysis of public policy questions and more advanced economics courses. Note: Coverage similar to M221 but slightly more advanced and addressed to students with greater previous exposure to quantitative analysis. Offered by the Department of Economics as Economics 2060.

M223 - ECONOMIC THEORY. Continues an intensive study of micro-economic theory relevant to public policy analysis, including such topics as industry regulation, Leontief models with substitution, general equilibrium, taxation, and redistribution. The presentation of theoretical topics will be organized around a few illustrative public policy issues. These may include pricing in regulated monopolies and public enterprises, energy planning, and policies for equalizing educational opportunity.

M224 - MACROECONOMIC THEORY AND POLICY. Explores modern macro-economic theory and its application to policy. Determination of the level, composition, and growth of national income and product will be discussed, as well as some of the following issues: employment and inflation; fluctuations and growth; problems of macroeconomic management: fiscal and monetary policy; "incomes" policy; "Keynesian" versus "classical Monetarist" controversies; issues of fact, theory, strategy, and value. Note: Offered by Economics Department as Economics 2061b

M225 - THE MACROECONOMIC STRUCTURE OF THE U.S. ECONOMY. Acquaints students with the major national accounting schemes currently in use, especially the National Income and Product Accounts, and Input-Output--the motivating paradigm, defining concepts, logical structure, and problems of implementation. Explores the salient magnitudes that characterize the U.S. economy, to help students become numerate; illustrates the problems that arise when one tries to use the numbers to answer

particular questions, questions about the allocation of resources (consumption versus investment, public versus private uses, etc.); the distribution of income; the organizational structure of the economy (e.g., the size and role of government). The course incorporates two or three major exercises in estimation; the cost of rising energy prices and the distributional impact of inflation are possible topics. Note: Enrollment limited to 20 students. All participants will be expected to have some familiarity with microeconomic principles.

M228 - ECONOMIC PRINCIPLES AND PUBLIC POLICY. Explores and develops economic principles applicable to a wide range of government policy. Specific topics include energy, crime, taxation, health care, income maintenance, population, environmental protection. Emphasizes common principles and analytical methods, not development of expertise in particular fields of policy. Note: This course is offered by the Department of Economics as Economics 1021, and is not open to students who have taken M271.

M271 - LAW AND PUBLIC POLICY: POLICY ANALYSIS. Explores ways of thinking about policy choice and problem solving that have origins outside the law but are increasingly important for lawyers in private and public life. Decision analysis, including formulation of the problem, identification and evaluation of alternatives, choice of action--both normative and as benchmarks for predicting behavior--is examined. Bargaining--formal and informal interactive processes among individuals or organizations when interests partly conflict--is also discussed, as well as social processes in which a large number of individuals interact anonymously. Will focus on evaluation of outcomes and of social intervention to affect outcomes, giving special attention to market behavior. Application to contemporary issues are presented for illustration. Note: Offered by the Faculty of Law as Law and Public

Policy A1. Open to MPA students in the Kennedy School, to Law students, and to students in other graduate programs of the University.

M302 - TESTING AND SORTING, AND THE DISTRIBUTION OF INCOME. Seminar will explore conceptual models of testing and sorting, whose application ranges from minimum competency testing for high school graduates, to mainstreaming of the handicapped, to selecting individuals for jobs, to defining acceptable criteria for admissions processes or insurance rating. Empirical studies on subjects such as the reliability of tests and the effects of various sorting mechanisms on the size and distribution of income will be reviewed. Each student will be expected to prepare a major paper. Note: Intermediate economic theory and introductory econometrics are prerequisites.

M310m - DEMOGRAPHIC ANALYSIS FOR POLICY. Studies the use of two tools--standardization and population projection--for analyzing and predicting demographic efforts. Applies these techniques to policy areas in which the size and age structure of a population are a significant and predictable influence, including the educational system, crime, the labor force, social security, and the evaluation of environmental risks. Students will be asked to analyze a case of their own choosing.

M331 - DATA ANALYSIS AND STATISTICAL TECHNIQUES. Introduces the student to statistical methods of special interest and use to lawyers. Methods of statistical analysis are examined in the context of concrete legal problems, in which statistics are used to resolve private controversies or issues of public policy. Note: Open to MPA candidates in the Kennedy School, to Law students, and to students in other graduate programs of the University.

M332 - EMPIRICAL ANALYSIS FOR PUBLIC CHOICE. Applies probability models and statistical techniques to questions of public concern.

Topics include the analysis and prediction of individual discrete choices. Social experimentation and the analysis of experimental data versus observations collected by more traditional surveys are considered. Empirical studies used throughout the course to demonstrate methods of analysis. A major feature will be individual empirical papers.

M333 - POLICY APPLICATIONS OF BASIC STATISTICS. Covers, in rapid format, basic ideas in collecting and interpreting quantitative evidence for policy. Topics include measures of variation, major probability distributions, estimation and inference from samples, significance testing, regression and correlation, interpreting data from tables, analysis of variance, and qualitative responses. Examples targeted to illustrate policy consequences of different ways of interpreting data. Cases include settings where regulations or legislation can be influenced by quantitative studies. Note: Course is designed for people who have prior experience or course work in statistics and data analysis. May be taken as preparation for M335. Those with no prior exposure to statistics and data analysis should take M331.

M334 - DATA ANALYSIS. Explores how models can be build and assessed at the same time, how possible breakdowns in assumptions can be diagnosed and cured in applying regression analysis and related statistical techniques to policy problems. The issues discussed respond to the difficulties frequently faced by the analyst: there is no convincing a priori model to test; and there is no guarantee that the assumption of least squares is met. Each student will prepare an original empirical analysis of a public policy issue. Note: Previous training in regression analysis required.

M335 - DEVELOPING EMPIRICAL EVIDENCE FOR POLICY. Treats issues of designing and interpreting studies to provide empirical

evidence playing a crucial role in public decision making. Three stages are presented in the development of evidence: Structuring a quantitative inquiry, collecting data, and drawing conclusions from analysis of the data. Topics include choice of experimental design, including randomization and matching, and cross-sectional versus longitudinal studies; choice of unit of analysis; sample surveys; creation of indices; issues of data quality, including bias and imprecision; multiple regression; aggregating results from several studies; Monte Carlo simulation. Will focus on those circumstances which require the analyst to exercise statistical judgment. Illustrated with examples from fields such as day care policy, police patrol, health policy, preschool programs. Note: An introductory statistics course, such as M331 or the Graduate School of Education's P012, is a prerequisite.

M805 - SEMINAR: USES AND LIMITATIONS OF SOCIAL SCIENCES IN PUBLIC POLICY. Presents analysis and criticism of the concepts, techniques, and data brought to bear by some of the social sciences on social problems of one sort or another, of the institutionalization of these efforts in public and private agencies, and of their inherent and other limitations and possibilities. Note: Open to qualified undergraduates. Offered by the Department of Government as Government 242.

M959 - WRITING FOR GOVERNMENT. Surveys the skills appropriate to various forms of written communication in government, including internal memoranda, studies or reports, bill drafts, testimony, press releases, speeches. Intensive exercises and critiques. Note: Enrollment is limited. Permission of the instructor is required.

VII. THE PERSPECTIVE OF POLICY RESEARCH INSTITUTES

In 1977 there were more than 100 universities graduate programs that offered degrees in public policy or one of its variants such as public affairs, public administration and policy analysis. In that same year Coulter (1977) suggested the nature of policy sciences was not yet well established. To illustrate this position, he referenced a current survey of chairpersons of political science departments and directors of interdisciplinary programs to indicate that there were a variety of perspectives regarding the relative importance of instructional policy study issues such as "matter versus substance" and "policy formation versus policy evaluation."

An examination of the empirical evidence in this survey--and other contemporary literature on the alternative paths for public policy studies and its curriculum--lead him to the position that virtually all of the research on policy science reported to date had taken the "perspective of academicians responsible for training policy scientists. He suggested an other important viewpoint was that of the policy research institute, a major employer of policy scientists.

To provide information on this perspective, a "purposive sample" with response information from 34 major United States policy research institutes with large federal government contracts to complete behavioral science studies was analyzed. We turn now to a brief review of his design and findings.

TABLE 6

RATING OF DISCIPLINES IN COULTER (1977)

	Discipline	Mean Score	Index of Disagreement
1.	economics	2.47	33.4
2.	public administration	2.00	44.4
3.	sociology	1.85	55.0
4.5	business administration	1.82	47.7
4.5	political science	1.82	49.4
6.	social psychology	1.76	62.5
7.	demography	1.71	53.1
8.	psychology	1.62	67.9
9.	law	1.59	49.3
10.	anthropology	0.88	95.9
11.	history	0.73	90.5
12.	agricultural economics	0.71	123.2
13.	philosophy	0.32	146.8

Question: "Various academic disciplines claim relevance to the social/behavioral analysis of public policy. In terms of the experience of your research firm, how would you rank the following disciplines with respect to their usefulness in public policy analysis? Circle your answers." (Extremely useful = 3, appreciably useful = 2, somewhat useful = 1, not useful = 0.)

Components of Policy Science. Coulter suggests policy science can be viewed from four different (but interrelated) training components. These are discipline, process, substance and technique. Questionnaire items, response scales and information on the response distributions for each of these training components appears in Tables Six through Nine.

Disciplines. From the viewpoint of practicing policy scientists, is there a single most useful discipline? Given agreement that policy science is "multidisciplinary" (or interdisciplinary), what combination of disciplines is perceived to be most valuable?

TABLE 7

RATING OF POLICY PROCESSES IN COULTER (1977)

	Policy Processes	Mean Score	Index of Disagreement
1.	public finance and budgeting	2.15	44.6
3.5	planning	2.12	41.5
3.5	service delivery	2.12	44.8
5.	implementation	2.00	53.5
6.	organization theory	1.91	43.4
7.	administrative process	1.82	43.9
8.	citizen participation	1.50	64.0
9.5	legislative process	1.41	52.5
9.5	judicial process	1.41	52.5
11.	accounting	1.38	68.8
12.	personnel administration	1.26	65.9

Question: "In addition to disciplinary perspectives, a graduate training program can also include one or more policy process specialties. For the ones listed, please rank their desirability. Circle your answers." (Extremely useful = 3, appreciably useful =2, somewhat useful = 1, and not useful = 0).

Table Six results suggest the perspective provided by graduate training in economics is perceived to be more useful than any other. The relatively low index of disagreement (which is the coefficient of relative variability computed as 100 times the standard deviation divided by the mean) also indicates the status for economics approaches unanimity. In second place, but below the value placed on economics is public administration. General agreement appears for the three disciplines (closely clustered) of sociology, political science and business administration.

Policy Process. Without regard to preferred discipline Coulter uses the questionnaire item in Table Seven to focus on

TABLE 8

RATING OF SUBSTANTIVE POLICY AREAS IN COULTER (1977)

	Policy Area	Mean Score	Index of Disagreement
1.	public health	2.53	34.1
1.	transportation	2.35	31.1
3.	law enforcement and criminal justice	2.29	43.7
4.	energy	2.25	45.1
5.5	Environment and natural resources	2.21	41.3
5.5	manpower	2.21	36.4
7.	poverty and social welfare	2.09	44.5
8.	economic development (LDCs)	2.06	47.6
9.	community development	2.03	39.4
10.	education	1.97	45.7
11.	housing	1.88	43.1
12.	mental health	1.70	48.5
13.	status of minorities	1.41	78.1
14.	family planning	0.88	87.5
15.	agriculture	0.82	115.6
16.	foreign policy	0.75	97.4

Question: "Most contract research apparently requires expertise in one or more substantive or policy areas. Several such areas are listed below. With reference to a graduate training program to train social/behavioral contract research professionals, how desirable do you feel each is as a major or policy specialty? Circle your answers. (Extremely useful = 3, appreciably useful = 2, somewhat useful = 1, not useful = 0).

what if anything should the policy scientist working in a policy research institute know about the processes by which public policy is shaped?

While responses from the practitioners provide insights, no single, clear-cut policy process entry emerges. Coulter's interpretation (supported in the reported distributions) is that "policy preparation in policy science is best served by studying public finance and budgeting, planning, service delivery and management."

TABLE 9

RATING OF ANALYTICAL TECHNIQUES IN COULTER (1977)

	Analytical Technique	Mean Score	Index of Disagreement
1.	program evaluation	2.76	22.1
2.	benefit/cost analysis	2.71	19.2
3.	experimental design and analysis of variance	2.65	20.4
4.	sampling	2.59	21.1
5.5	survey research	2.50	37.2
5.5	questionnaire and protocol design	2.50	31.6
7.	multivariate statistics	2.41	29.0
8.	computer programming	2.23	36.8
9.	case study methods	2.18	39.9
10.	econometrics	2.12	41.5
11.	mathematical statistics	2.06	35.9
12.	use of "canned" programs	1.94	50.5
13.5	linear programming	1.62	56.8
13.5	psychometrics	1.62	62.3
15.	sociometry	1.50	66.0
16.	the calculus	1.32	76.5

Question: "Please rank each of the following kinds of analytical and methodological skills in terms of their usefulness to a social/behavioral scientist in your firm." Circle your answers. (Extremely useful = 3, fairly useful = 2, only slightly useful = 1, and not too useful = 0.)

Policy Areas. The institute questionnaire also inquired about the value of substantive policy area training in graduate school preparation for a policy science career. Coulter's position on responses to policy area items in Table Eight is that those items with mean scores above 2.0 are seen by practitioners as "appreciably useful."

Analytical Techniques. The Table Nine results for the ranking of the sixteen techniques suggest that a "impressively" large number, eleven to be specific, receive an average score of "appreciable" or higher.

Program evaluation and benefit/cost analysis draw both high ratings and substantial agreement among responding practitioners. In this instance, Coulter notes "both of these are complex, synthetic techniques in that each requires a series of sequenced steps involving both conceptualization and measurement and thus assumes a variety of technical skills." Among these are the skills from the mathematical sciences and the mathematical social sciences. In Coulter's list, they include the "highly rated" analytical skills entries for experimental design and analysis of variance, sampling, survey research and questionnaire and protocol design. The response patterns for multivariate statistics, computer programming, case study, econometrics and mathematical statistics (a central core or pure mathematics discipline in the National Academy of Sciences classification for the mathematical sciences described in Section Two) all suggest that these are highly valued tools of policy science.

Comparisons Among Training Components. Table Ten results indicate that analytic technique is the most useful, while training in an academic discipline is least valued (but still an essential perspective given a mean score of 1.92 with this decision rule for ranking).

Conclusions. In light of the research needs of policy research institutes, economics is "the choice disciplinary avenue to policy science competence." However, the response

TABLE 10

COMPARISON OF IMPORTANCE OF
DISCIPLINE, PROCESS, SUBSTANCE AND
TECHNIQUES IN COULTER (1977)

Training Components	Mean Score
1. Technique	2.54
2. Substance	2.24
3. Process	2.07
4. Discipline	1.92

Decision Rule for Ranking: One answer to the question "what should the relative emphasis be on these four components in a policy science training program?" is provided by computing the average of the entries in the top half of each training component.

patterns from practitioners suggest that disciplinary avenue to policy science is less important than analytic expertise, policy substance or policy process.

Coulter's overall position on his study deserves careful examination. He notes "Two equally plausible interpretations of the evidence are possible. The pessimistic conclusion is that policy science is incoherent. The optimistic conclusion is that policy science is flexible. In either case, since it is still in its infancy, there is sufficient time to develop a policy science that is both coherent and flexible."

VIII. COMPUTER AND INFORMATION SCIENCES

Essay Question Addressed is Eleven

How have the decision sciences influenced the graduate study options in university departments of computer and information sciences?

Response Themes to be developed.

1. Computer and Information Science (C.I.S.) and Decision Science (D.S.) are both interdisciplinary and draw from the same disciplines. Among these are the pure and applied mathematical sciences and the social and behavioral sciences.

2. C.I.S. and D.S. have similar research domains and, hence, overlaping research topics and projects. C.I.S. at Ohio State. the case study for this chapter has sponsored research in these areas:
    1. Theoretical information science
    2. computer networks and distributed processing
    3. software engineering and program testing
    4. artificail intelligence
    5. exiomatic data specification
    6. data security and data base computers
    7. theoretical models of programming language
    8. computer graphics
    9. analysis of algorithms

3. C.I.S. and D.S. have similar instructional domains and, hence, overlaping instructional emphasis. At O.S.U., these emphasis are:
    1. General theory of information.
    2. Information storage and retrieval.
    3. Theory of automata and theory of computation.
    4. Artificial intelligence.
    5. Pattern recognition.
    6. Computer programming, including system programming
    7. Theory and processing of programming languages.
    8. Digital computer architecture and organization.

9. Numerical analysis.
10. Man-machine interaction and systems.
11. Formal and computational linguistics.
12. Management information systems.
13. Biological information processing.
14. Social, economic, and psychological aspects of information production and processing.

4. C.I.S. and D.S. have overlap in their career emphasis. At O.S.U. the options for a first professional (master's degree) are these:

OPTION I	for the student desiring a theoretical foundation in computer and information science.
OPTION II	for the student specializing in information systems.
OPTION III	for the student specializing in computer systems.
OPTION IV	for the student specializing in numerical analysis.
OPTION V	for the student specializing in operations research.
OPTION VI	for the student specializing in biomedical information processing
OPTION VII	for the student specializing in administrative science.
OPTION VIII	for the student specializing in mathematics.
OPTION IX	for students specializing in computer hardware and software who have appropriate undergraduate background.

5. Information Specialist in Schools of Library and Information Science often have instructional and research tasks similar to those in Decision Sciences. Accordingly, see insert on Drexel University.

IX. LEADERSHIP

Essay Questions Addressed

13. What are the major instructional domains (core competency areas and specializations) addressed in graduate vocational education leadership development and training programs?
14. How can the decision sciences influence educational management and administrative leadership?
15. How can the decision sciences influence curriculum and instruction?
16. How can the decision science influence leadership in the development of research skills?
17. In what ways can the decision sciences influence efforts to improve and extend the emphasis of the social and behavioral sciences in interdisciplinary vocational teacher education programs?

X. FUTURE DIRECTIONS

Essay Question Addressed

18. What are some specific directions for the immediate future?

NOTE: THESE TWO SECTIONS WILL BE ADDRESSED IN THE WORKSHOP SESSION ON FEBRUARY 18. APPENDIX THREE CAN BE STUDIES AS PART OF THE RESPONSE TO QUESTION 14, APPENDIX FIVE FOR QUESTION 15 AND APPENDIX SIX FOR QUESTIONS 16 AND 17.

NOTES

1. This elaboration of positions was found in Opportunities for Advanced Graduate Study in Vocational and Practical Arts Education at The Ohio State University, jointly published by the Department of Agricultural Education, Department of Home Economics Education, Faculty for Industrial Technology Education, and the Faculty for Vocational-Technical Education in cooperation with the National Center for Research in Vocational Education.
2. Human resources development is a general field and subject to wide interpretation among universities. What I have in mind is the perspective illustrated in The Ohio State University Human Resources Management Seminars. Individual workshops include (1) Effectively Administering Your Human Resources, (2) Current Human Resources Legislation, (3) Applying Compensation Administration Techniques, (4) Effectively Managing Conflict Situations, (5) Applying Job Analysis Techniques, and (6) The Job Attitude Survey as a Management Tool. Details and objectives for each of these workshops appear in an announcement entitled, Human Resources Management Seminars: Spring Series 1981 available from The Ohio State University, College of Administrative Science, Division of Continiung Education. See also Parnes (1976).
3. The discussion of the various disciplines of the mathematical sciences relies extensively on this source which will be cited as National Academy of Sciences (1968).
4. In National Academy of Sciences (1968, Chapter 5) a revealing statement on just what "something else" might imply is as follows: "just as it's still a methodological science, a computational science, and a behavioral science, statistics continue to be a mathematical science." Another view on "something else" can be found in the International Encyclopedia of Social Sciences. See especially the treatments of "Probability" in (Volume 12, 487-505) and "Statistics" in (Volume 15, 206-232).

5. Such fields are excellent reminders to those who view mathematics solely as "the science of numbers" that mathematics is the art of symbolic reasoning and, therefore, is far more versatile than just a computation device. Two excellent nontechnical discussions on this topic are Kemeny (1969) and Smith (1979).
6. This volume will be cited as National Academy of Sciences (1969).
7. Trends elaborated in this section rely on remarks offered in Valentine and Mennis (1980). Brief quotes acknowledged here are from the preface.
8. An illustration of this type of graduate offering is The Ohio State University course Business Finance 823: Quantitative Methods in Investment Management which is described in Appendix One.
9. For example, at The Ohio State University there is a Ph.D. program in quantitative methods in the College of Administrative Sciences and a doctoral level specialization in quantitative methods (emphasizing primarily statistics) in the College of Education. An excellent and detailed description on graduate quantitative methods programs in schools (or colleges) of education in the United States and Canada appears in Bruno and Fox (1973). For a view toward its potential in educational organizations see Bruno (1976) and McNamara (1979).
10. An examination of the appendices provides several additional contemporary illustrations for the 1968 N.A.S. report projections suggesting that the mathematical sciences would have a strong and continiung influence on fields that had been shielded from mathematics until recent years.
11. The section on the mathematical social sciences draws extensively on information provided in the University of Michigan's Institute for Social Research announcement entitled Inter-University Consortium, Political and

Social Research 1980 Training Program in The Theory and Technology of Social Research. (Available from I.S.R., Box 1248, Ann Arbor, Michigan). Appendices are listed in the monograph in the order they were constructed during my project residence here at the Advanced Study Center. While this procedure bypasses the usual convention (to number them in the order they enter the narrative), the alternate sequencing might be of some significance in following my progress through the ten month inquiry.

12. The use of a term such as "quantitative empirical social research" rather than "mathematical social sciences" in this section follows the practice established in I.C.P.S.R. publications and announcements.

13. Readers who reside in established research universities are encouraged to study their graduate bulletins and prepare similar lists as a means to explore new graduate degree options in support fields.

14. Teaching universities are institutions with master's programs (often with large numbers of part-time students), few (if any) doctoral programs, small operating budgets dedicated exclusively to research, and no significant capital expenditures for research and development facilities. Teaching universities are often state supported, regional institutions that historically have had large commitments to undergraduate teacher education programs. In many instances most enrollments in their current graduate studies programs are also in teacher education and related fields.

15. The current impact of traditional academic operations research in the field is the issue. See Ackoff (1979a, 1979b) for a view on the need to merge operations research with the social and behavior sciences. This merger can be seen in a professional graduate studies program called "social systems science" which Ackoff and several operations research colleagues have implemented in the Wharton School.

16. Statements on the MDS at Georgia State University appear in two announcements, M.D.S. at Georgia State University and Department of Quantitative Methods. Both are distributed by the College of Business Administration at Georgia State University.

17. This document is available from A.I.D.S., Department of Quantitative Methods, Georgia State University, Atlanta, Georgia, 30303. When referenced it appears as A.I.D.S. (1976). Brief quotes in this section are from pages 2 through 5.

18. In general, basic (formal) decision science mathematics follows the directives provided by the Mathematical Association of America (1966) guidelines for applied mathematics and adhers to a curriculum in the mathematical training strategies offered for students in the biological, management and social sciences which suggest it is "important to recognize that they need mathematics primarily as a language for scientific reasoning, and that they do not need as much training in detailed techniques as mathematics and physical science students." (Mathematical Association of America, 1964, p. 5)

19. This publication remains the best, single source I have uncovered on the decision sciences since I began my Advanced Study Center project in April 1980. The elaboration of decision sciences efforts reported in this case study draws heavily on this source and my field visit to the Decision Sciences program at the University of Pennsylvania in June 1980. Readings in Decision Sciences, (a journal first published by A.I.D.S. in 1970) were also helpful as were decision science entries offered in 1980-81 catalog (and other publications) of the Stanford University Graduate School of Business and similar document entries (including the 1980-82 doctoral program announcements) from the J.L. Kellogg Graduate School of Management at Northwestern University.

20. An alternate structure for the domains of decision science appears in the Stanford University program which uses five rather than three primary domains for organizing research and teaching. Their domains are (1) Applied Probability, and Stochastic Control, (2) Applied Statistics and Econometrics, (3) Decision Theory, (4) Mathematical Programming. and (5) Operating Systems. In their doctoral program, each student must choose three of these areas. A special area, Management Science may be substituted for one of the three areas by students who wish to focus their research and teaching interest in the application of "quantitative" approaches to operating systems or marketing. A second alternate structure for decision science domains appears in the Department of Managerial Economics and Decision Sciences at Northwestern University. Both alternate perspectives readily appear in the current graduate catalogs.

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Appendix One

SELECTED QUANTITATIVE METHODS COURSES

From

THE 1979-80 OHIO STATE UNIVERSITY BULLETIN

Prepared by

James F. McNamara
Advanced Study Center
Ohio State University
1960 Kenny Road
Columbus, Ohio 43210
(Tel. #800-848-4815)

For Discussions Regarding

THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION

LEADERSHIP DEVELOPMENT PROGRAMS

(A 1980 Advanced Study Center Project)

(July 1980)

ACCOUNTING

ACCT 522 - Financial Accounting (5 hours). Application of accounting techniques and theory to recording and reporting of financial data; emphasis on collection, summarization, and reporting of data in accordance with generally accepted accounting principles.

ACCT 631 - Computer Accounting in Business (5 hours). The design, programming, and auditing of computer based accounting information processing systems.

ACCT 711 - Introduction to Management Accounting (5 hours). A survey of accounting principles from the viewpoint of management; income measurement; analysis and interpretation of accounting data, internal reports.

ACCT 811 - Business Controls (3 hours). Examination of business planning and the controls over operations and property; the use of accounting data in the management enterprise.

AGRICULTURAL EDUCATION

AGR EDUC 885 - Research Methods (3 hours). Principles and techniques of research appropriate for planning, conducting, and reporting research in vocational, technical, and extension education.

AGR EDUC 886 - Research Design (3 hours). Development of effective design for research problems in vocational, technical, and extension education, including theory, models, and sampling.

AGR EDUC 887 - Analysis and Interpretation of Data (3 hours). Application and interpretation of descriptive and inferential statistics for research in vocational-technical and extension education, including the use of the computer.

BUSINESS ADMINISTRATION: FINANCE

BUS-FIN 721 - Managerial Finance (4 hours). Financial management of business units with emphasis on finance organization structure, collecting and using financial data, judging profitability, liquidity, sources of capital internal financial operations.

BUS-FIN 728 - Quantitative Methods In Managerial Finance (4 hours). Application of mathematical and statistical methods in formulating and solving problems of financial management.

BUS-FIN 729 - Cases in Managerial Finance (4 hours). Analysis of qualitative and quantitative financial factors involved in managerial decisions in actual business cases.

BUS-FIN 821 - Seminar in Corporate Financial Analysis (3 hours). Critical study of the growing number of analytical techniques and research findings that lie between present practices and the frontiers of financial research.

BUSINESS ADMINISTRATION: FINANCE (continued)

BUS-FIN 823 - Quantitative Methods in Investment Management (3 hours). Recent developments in quantitative methods applied to investment analysis and portfolio management including the Markowitz portfolio model, random walk hypothesis, utility in risk analysis and valuation models.

BUSINESS ADMINISTRATION: MANAGEMENT SCIENCE

BUS-MGT 391 - Decision Sciences: Operations Research Techniques (4 hours). Examines the use of operations research techniques in managerial decision making processes; constrained linear optimization, non-linear optimization, network analysis, queuing theory, simulation.

BUS-MGT 491 - Decision Sciences: Statistical Techniques (5 hours). Examines the use of statistical techniques in managerial decision making processes; sampling and estimation, hypothesis testing, chi-square tests, simple and multiple regression, time series analysis.

BUS-MGT 601 - Business Statistics (2-5 hours). Price and production indexes; analysis of time series; linear correlation applied to economic and business problems.

BUS-MGT 691 - Decision Science: Managerial Applications (3 hours). Building and using mathematical models for planning and control of administrative processes. Integrates quantitative tools from 391 and 491 with functional business areas.

BUS-MGT 734 - Analysis and Design of Operating Systems (4 hours). Analysis and design of modern operations, including model building and computer simulation.

BUS-MGT 801 - Quantitative Methods in Business (3 hours). Derivation and application of analytical, mathematical, and statistical techniques to the solution of recurring management problems.

BUS-MGT 802 - Systems Research Organization and Methodology (3 hours). Modeling adaptive management systems of complex organizations such as health, business, and education.

BUSINESS ADMINISTRATION: MARKETING

BUS-MKTG 650 - Marketing (4 hours). Critical survey of field of marketing; structure, functions, policies, costs, and problems analyzed from consumer and other viewpoints; emphasis on principles, trends, and quantitative expression.

BUS-MKTG 758 - Marketing Research (4 hours). The role of research in the solution of marketing problems; emphasis on available data analysis and methods of the field of investigation.

BUSINESS ADMINISTRATION: MARKETING (continued)

BUS-MKTG 807 - Principles and Techniques of Marketing Research (3 hours). Principles of research methods in business and the use of research by management; scientific method in business, sampling theory, variable analysis, research cases.

BUS-MKTG 858 - Multivariate Analysis in Business Research (3 hours). Advanced consideration of correlational data analysis techniques (regression, discriminant analysis, factor analysis, canonical analysis). Emphasis is on comparison of techniques and underlying theory and assumption.

BUS-MKTG 859 - Topics in Cluster Analysis and Multidimensional Scaling (3 hours). Examination of the theoretical background behind multi-dimensional scaling and cluster analysis with the objective of developing sufficient understanding for problem-solving with the techniques.

CITY AND REGIONAL PLANNING

CTR PLAN 770 - Introduction to Quantitative Methods in Urban Planning (4 hours). Introduction of mathematical models in urban planning; descriptive statistics, probability, decision theory, and use of digital computer.

CTR PLAN 771 - Applications of Quantitative Methods in Urban Planning (4 hours). Applications of statistical analysis in urban planning; hypothesis testing and parameter examination methods; computer analysis of urban planning data.

CTR PLAN 780 - Workshop in Urban and Regional Planning Techniques (3 hours). Techniques in the urban and regional planning process: spatial distribution and management of population and economic growth in the city and the region, stressing the applied aspects of the techniques as used in the profession.

CTR PLAN 832 - Urban Planning Data and Forecasting (5 hours). Sources of information, data handling, forecasting, and basic studies in urban planning.

CTR PLAN 833 - Consequence Analysis in Urban Planning (3 hours). Urban planning studies using cost-benefit, cost-effectiveness, systems analysis, and PPBS approaches.

CTR PLAN 834 - Decision Analysis in Urban Planning (3 hours). Application of decision theory and analysis to case studies in urban planning.

CTR PLAN 870 - Workshop in Quantitative Methods in Urban Planning (3 hours). Workshop application of quantitative planning methods to an urban or regional planning problem.

COMPUTER AND INFORMATION SCIENCE

CMP IFSC 100 - Computers in Society (3 hours). An introductory course of general interest to all students, treating the actual and potential role of the computer in our society; does not teach or require computer programming.

CMP IFSC 505 - Fundamental Concepts of Computer and Information Science (5 hours). Introduction to the fundamental concepts of computer and information science: discrete mathematics, logic, computation theory and information theory.

CMP IFSC 511 - Computer Systems and Programming for Administrative Science (3 hours). Development of programming skills and techniques applicable to problems and practices in administrative science for students with no prior computer programming.

CMP IFSC 542 - Introduction to Computing in the Humanities (3 hours). Use of non-numerical programming language for editing and collating texts, for forming indices and concordances, and for studies of style, attribution, and literary influence.

CMP IFSC 548 - Computer Science for High School Teachers (5 hours). Introduction to computer history, organization, hardware and softwear; laboratory experience using batch processing and time-sharing; applications of computers with emphasis on uses in education and business.

CMP IFSC 610 - Principles of Man-Machine Interaction (5 hours). Systems concepts, their measurement and modeling; behavioral processes; sensing, learning, memory, complex information processing, and decision making; interface theory and interactive systems.

CMP IFSC 752 - Techniques for Simulation of Information Systems (3 hours). Introduction to the methodology and techniques of the design of computer simulation of information systems.

CMP IFSC 765 - Management Information Systems (3 hours). Theory and practice of management information systems from the viewpoint of computer and information science; systems approach to management and organization; significance of information.

ECONOMICS

ECON 532 - Public Expenditure and Cost-Benefit Analysis (5 hours). Economics of public choice, public goods, non-market allocations, collective decision-making, and net-benefit maximation; case studies.

ECON 550 - Economic Development (5 hours). Empirical and theoretical consideration of long-term economic changes, including changes in industrial structure, technology, and level of national product; emphasis on developing economics.

ECONOMICS (continued)

ECON 581 - Economics of the Labor Market (5 hours). Materials and methods of labor market analysis; the measurement and behavior of unemployment, employers' and employees' labor market behavior; wage determination and labor allocation.

ECON 600 - Applications of Mathematics in Economic Analysis (5 hours). Coverage of the most common applications of mathematics to economic analysis and econometrics; the necessary tools from matrix algebra and calculus are provided.

ECON 631 - Federal Finance and Fiscal Policy (5 hours). The economics of government spending and taxation; analysis of the fiscal role and instruments of government and their effects on the economy.

ECON 633 - State and Local Government Finance (5 hours). Economic analysis of revenues and expenditures of state and local governments; vertical and horizontal relationships between agencies and units; specific problems in these areas.

ECON 640 - Probability and Statistical Decision Theory (5 hours). Theory of probability and stochastic processes; statistical inference, tests of significance and analysis of variance; statistical decision theory.

ECON 641 - Applied Regression and Correlation Analysis (5 hours). The general linear regression model; multiple correlation, path analysis, analysis of variance and tests of significance; specification errors.

ECON 740 - Inference and Decision Analysis under Uncertainty (5 hours). Distribution theory, point and interval estimation, statistical hypothesis testing, decision analysis under uncertainty.

ECON 741 - General Linear Regression Analysis (5 hours). Multiple regression analysis; the general linear model; non-linear and distributed lag models.

EDUCATIONAL FOUNDATIONS AND RESEARCH

ED-F&R 769 - Quantitative Techniques for Educational Decisions (3 hours). Principles and problems associated with utilization of quantitative techniques and procedures for educational decision making.

ED-F&R 786 - Introduction to Inquiry: Quantitative Methods (3 hours). An introduction to quantitative techniques, with emphasis on application in educational settings.

ED-F&R 789 - Population Analysis and Educational Planning (3 hours). A seminar designed to study population trends, movements, and distributions as they relate to more effective planning for school systems.

EDUCATIONAL FOUNDATIONS AND RESEARCH (continued)

ED-F&R 791 - Information Processing in Education (4 hours). Major emphases are placed on current applications, limitations, problems, and potential of data processing, information system, and computer technology in education.

ED-F&R 807 - Educational Survey Research Methods (3 hours). A study of the design principles, sampling and data-gathering methods used in the conduct of educational survey research.

ED-F&R 808 - Experimental Design in Education I (3 hours). An examination of logical and quantitative principles, especially the analysis of variance, underlying basic experimental designs employed in educational research.

ED-F&R 809 - Experimental Design in Education II (3 hours). An examination of intermediate quantitative principles underlying experimental design in education, such as repeated measures designs, hierarchial designs, and the analysis of covariance.

ED-F&R 820 - Program/Project Management (3 hours). The use of management information systems in the planning and controlling of educational research and development projects, with particular emphasis on network planning techniques.

EDUCATION FOR EXCEPTIONAL CHILDREN

ED-EXCEP 986 - Developmental Assessment I (3 hours). Use of testing and observational techniques in developmental assessment with major emphasis on collecting and evaluating data related to global cognitive and affective functioning.

ED-EXCEP 987 - Developmental Assessment II (3 hours). Continuation of 986, with emphasis on the techniques developed to assess specific abilities and disabilities for educational planning.

ED-EXCEP 988 - Developmental Assessment III (3 hours). Continuation of 987, with emphasis on the analysis, synthesis, and interpretation of data.

ED-EXCEP 989 - Developmental Assessment IV (3 hours). Continuation of 988, with emphasis on intervention and the evaluation of intervention techniques.

GEOGRAPHY

GEOG 580 - Elements of Cartography (5 hours). A study of the cartographic techniques of map compilation and presentation including generalization, symbolization, reproduction, and simple computer mapping.

GEOG 670 - Population Geography (5 hours). Analysis of population distributions, locational arrangements of growth, densities, and migration flows; spatial relationships between population variables and social, economic, and environmental factors.

GEOGRAPHY (continued)

GEOG 800 - Seminars in Regional Geography (3-5 hours). The development of theory in regional development and its application to selected problems.

GEOG 850 - Seminars in Urban Geography (3-5 hours). The development of theory in urban geography and its application to selected problems.

GEOG 870 - Seminars in Population and Social Geography (3-5 hours). The development of theory in population and social geography and its application to selected problems.

GEOG 883 - Application of Quantitative Methods in Geography (4 hours). Application of quantitative methods to geographic problems; spatial statistics, area sampling, maps of residuals, regionalization methods, and simulation maps.

GEOG 983 - Special Topics in Quantitative Geography (5 hours). Applications of advanced mathematical and statistical models to problems in geographical analysis.

HOSPITAL AND HEALTH SERVICES ADMINISTRATION

HHSA 831 - Planning for Health Organizations (3 hours). Description of techniques and methods essential for planning with an emphasis on applications in social technical systems and a special emphasis on health systems.

HHSA 850 - Seminar in Hospital Policy and Decision-Making (4 hours). Policy process and methods of decision making; assignment and solution of managerial problems; case studies, with emphasis on strategy and implementation.

HHSA 860 - Evaluation in Health and Other Social Systems (3 hours). Models of evaluation including experimental designs, quasi-designs and case studies with discussion of barriers to effective use of evaluation results in health administration decision-making.

HHSA 861 - Behavioral and Normative Decision Approaches (3 hours). Decisions as made by individuals, groups and organizations comprising the health delivery systems; examination of decision-maker behavior; strategies to improve decisions.

INDUSTRIAL AND SYSTEMS ENGINEERING

IND ENG 501 - Work Systems Analysis and Measurement (3 hours) Analysis of work content; measurement of the performance of man-machine systems; establishment of standards for the evaluation of work.

IND ENG 649 - Quantitative Design Methods in Systems Engineering I (3 hours). Model formulation and solution methods for system design problems with emphasis on matrix and vector space methods for static and dynamic systems.

IND ENG 650 - Quantitative Design Methods in Systems Engineering II (3 hours). Use of mathematical techniques; including finite calculus, Fourier analysis, and assorted transforms in the analysis of industrial engineering systems.

IND ENG 653 - Engineering Data Analysis (3 hours). Graphical and other special techniques for estimating parameters and testing goodness of fit of non-normal distributions to engineering data.

IND ENG 654 - Simulation of Complex Systems (5 hours). Introduction to the analysis of systems via discrete, continuous, and combined discrete-continuous computer simulation models. Generation of random variables.

IND ENG 660 - Quantitative Health Systems Management Methods (3 hours). A survey of operations research methods applied to health delivery. Includes model design and analysis and application projects in area hospitals.

IND ENG 662 - Introduction to Applied Decision Analysis (3 hours). Introduction to decision analysis and its application. Deals with modern utility theory and the application of this theory to engineering decisions under risk.

IND ENG 755 - Application of Benefit-Cost Analysis (3 hours). Multiple criteria decision making; application of benefit-cost analysis, cost-effectiveness analysis, and multi-attribute decision theory.

IND ENG 762 - Applied Decision Analysis (3 hours). Exploration of strategies for translating decision analyses, staff studies, and engineering decisions into practice; examination of available data in psychology, sociology, and organizational analysis.

IND ENG 842 - Operations Research I (3 hours). Introduction to the nature and problems of operations research and the study of actual case histories in the field.

IND ENG 843 - Operations Research II (3 hours). The position of the model in operations research and the study of the important techniques and formal approaches to research problems.

IND ENG 844 - Operations Research III (3 hours). Consideration of topics in operations in research including research methodology in the various sciences, and the conduct of actual operations research investigations.

LABOR AND HUMAN RESOURCES

LHR 653 - Human Resource Planning (4 hours). Survey of concepts and techniques of human resources planning, with special emphasis on projections of human resource requirements.

LHR 852 - Issues in Human Resource Policy (4 hours). Analysis and evaluation of selected public policies and programs relating to human resource allocation, conservation, and utilization.

LHR 854 - Evaluating Human Resources Programs (4 hours). A review of evaluation technology and its application to human resources programs.

LHR 867 - Seminar in Public Sector Human Resources Administration (4 hours). Analysis of problems in public sector human resources management with emphasis on the nature of the employment relationship, research strategies, and policy evaluation.

MEDICAL RECORD ADMINISTRATION

MED REC 501 - Health Information Documentation, Analysis, Storage and Retrieval Systems (5 hours). Introduction to patient information systems; quantitative and qualitative evaluation of record format and documentation; the medical record administrator's responsibilities for design, implementation, management of systems.

MED REC 503 - Health Information Statistics and Research Methodology (5 hours). Computation, presentation and analysis of health and administrative statistics, including definitions, sources, collection and reporting systems; medical record administrator's role in research methodology.

MED REC 510 - Legal, Legislative and Confidentiality Issues of Health Information Systems (3 hours). Evaluation of the medical record as a legal document consistent with medical and legal requirements of the health care delivery system; confidentiality and data security.

POLITICAL SCIENCE

POLIT SC 570 - Alternative World Futures (5 hours). Examines forecasts of the future made by computer simulation, and by philosophers and science fiction writers; discusses ways to change the future through political means.

POLIT SC 679 - Policy Analysis (5 hours). An analysis of the policy process emphasizing the determinants of public policy, theories of public choices, and the implementation, impact, and evaluation of policy decisions.

POLITICAL SCIENCE (continued)

POLIT SC 684 - Introduction to Political Science Research Methods (5 hours). Introduction to political science research with emphasis on survey and experimental designs, data generation techniques, data processing, and computer utilization.

POLIT SC 685 - Methods of Quantitative Analysis: Elementary (5 hours). Explication, interpretation, and application of techniques for quantitative analysis of political data; descriptive and inferential statistics, with emphasis on bivariate analysis.

POLIT SC 686 - Methods of Quantitative Analysis: Intermediate (5 hours). Descriptive and inferential statistics with emphasis on multivariate analysis; additional topics offered as desired and possible: scaling, index construction, sampling, measurement reliability.

POLIT SC 702 - Public Opinion and Political Behavior: Psychological Foundations (5 hours). The formation, organization, and change of attitudes about American politics; methods of survey design and analysis including computer adaptations.

POLIT SC 747 - Research Methods in International Politics (5 hours). Examines a number of research techniques and approaches common in international politics such as content analysis, simulation, mathematical modeling and factor analysis.

POLIT SC 779 - Readings on the Policy Process (5 hours). Consideration of the basic theories, concepts, and techniques used in the policy analysis; the determinants of public policy; and the impact and evaluation of public policy.

POLIT SC 786 - Causal Analysis (5 hours). Analysis of causal models by Simon-Blalock techniques, recursive and nonrecursive path estimation; special topics include measurement error, standardization, and ordinal data.

POLIT SC 787 - Dimensional Analysis (5 hours). Topics include measurement and data theory, unfolding, proximity and dominance (Guttman) scaling, multidimensional scaling, and factor analysis.

POLIT SC 788 - Mathematical Theories of Politics (5 hours). Introduction to various major mathematical theories of political phenomena and the role of formal analysis in political science.

POLIT SC 790 - Scope and Methods of Political Science (5 hours). An introduction to political science as a scholarly discipline; examination of trends, concepts, and scientific foundations; an overview of theory building and theory testing.

POLITICAL SCIENCE (continued)

POLIT SC 803 - Research in Public Opinion (5 hours). Development and execution of a research design focusing on a problem in American public opinion; consultation on substantive and methodological problems offered by instructor.

POLIT SC 813 - Research on Executive and Bureaucratic Politics (5 hours). Development and execution of a research design focusing on a problem in American executive and bureaucratic politics; consultation with instructor on substantive and methodological problems.

POLIT SC 817 - Research in Legislative Politics and Policy-Making (5 hours). Development and execution of a research design focusing on a particular problem in American legislative research; consultation on substantive and methodological problems offered by instructor.

POLIT SC 867 - Research in Mathematical Political Theory (5 hours). Design and execution of research focusing on a problem in mathematical political theory.

PSYCHOLOGY

PSYCH 511 - Psychological Testing (3 hours). An overview of theoretical and practical aspects of the assessment and prediction of human behavior; topics include achievement, intelligence, personality, attitudes, interests, and interpersonal relations.

PSYCH 541 - Educational and Vocational Appraisal (4 hours). Theory and techniques of appraisal of individual characteristics as related to the formulation of future educational and vocational plans.

PSYCH 609 - Introduction to Quantitative Models in Psychology (4 hours). Review of mathematical model building in psychology with emphasis upon probabilistic techniques applied to aspects of learning, memory, and perception.

PSYCH 610 - Introduction to Quantitative Learning Models (4 hours). A continuation of 609; emphasis on non-Markovian models.

PSYCH 615 - Introduction to Mathematical Psychology (3 hours). Survey of current topics in mathematical psychology; topics include measurement and scaling, decision theory, signal detection theory, information theory, and mathematical learning theory.

PSYCH 616 - Psychological Scaling (3 hours). Course covers one-dimensional and multi-dimensional procedures for scaling; ordinal and metric procedures are discussed; theory and methods covered.

PSYCHOLOGY (continued)

PSYCH 621 - Personnel Psychology (4 hours). Content and methodology of personnel psychology, including such topics as job analysis, interviewing, test validation, selection and placement systems, performance appraisal, and training.

PSYCH 800 - Advanced Experimental Laboratory (3-15 hours). Advanced training in the experimental and quantitative methods in the several areas of general experimental psychology and comparative psychology.

PSYCH 810 - Methodological Foundations of Experimental Psychology (5 hours). Problems of definition of psychological concepts, formulation and testing of hypotheses, theory, construction, and formulation of empirical generalization with reference to design of psychological experiments.

PSYCH 815 - Decision Processes (4 hours). Introductory course in the application of statistical decision theory as a normative model and analytic technique in the experimental study of cognitive processes.

PSYCH 820 - Fundamentals of Factor Analysis (3 hours). Basic common factor analysis model and its application in psychology; model, communality estimation, factor extraction, orthogonal and oblique rotation, factor scores, interpretation, components analysis.

PSYCH 821 - Seminar in Field and Experimental Research Methods (3 hours). Logic of the research process, uses and limitations of major research strategies, and application of specific data gathering techniques with special emphasis on field settings.

PSYCH 823 - Theory of Test Construction (3 hours). Review of major approaches including traditional mental test theory, assessment theory, and decision theory in relation to constructing and use of various types of tests.

PSYCH 825 - Statistics in Psychology I (4 hours). First of a two-quarter sequence in inferential statistics; basic concepts of sets, probability, distributions, and foundations of inference and estimation; special applications to psychology.

PSYCH 826 - Statistics in Psychology II (4 hours). Continuation of 825; theoretical justification and uses of various inferential techniques; topics: t, x^2, F distributions, correlation and regression, non-parametric techniques.

PSYCH 827 - Analysis of Variance (4 hours). A coverage of statistical inference in analysis of variance designs; analysis of variance designs include randomized blocks, repeated measures, mixed models, and related contrast tests.

PSYCHOLOGY (continued)

PSYCH 828 - Correlational Analysis (4 hours). Techniques and rationale of using quantitative and qualitative data for prediction; test and battery analysis and validation.

PSYCH 833 - Methodological Problems in Developmental Psychology (3 hours). A bridge from formal statistics to current research in developmental and educational psychology with repeated measure, time series data, indices of change, etc.

PUBLIC ADMINISTRATION

PUB ADM 802 - Legal Environment of Public Administration (3 hours). An examination and analysis of the constraints imposed upon public administrative processes by the legal environment including judicial policy-making and the evolving legal order.

PUB ADM 804 - Seminar on Governmental Information Systems Administration (3 hours). Critical study of the administration and design of management information systems for public agencies; selected case studies.

PUB ADM 805 - Seminar on Systems Analysis for Public Policy Decision (3 hours). Studies in the application of systems analysis to administrative and policy problems in the public sector; selected case studies and problems.

PUB ADM 806 - Public Budgeting and Spending Decisions (3 hours). Budgeting as analysis of resource allocation, planning evaluation, and control; tools of analysis for program budgeting and measurement of program results; case studies.

PUB ADM 850 - Policy Problem Seminar I (3 hours). Multidisciplinary seminar integrated with field experience in the solution of actual public administrative and policy problems; organized around problem areas.

PUB ADM 867 - Seminar in Public Sector Human Resources Administration (4 hours). Analysis of problems in public sector human resources management with emphasis on the nature of the employment relationship, research strategies, and policy evaluation.

RURAL SOCIOLOGY

RURL SOC 642 - Concepts and Theories in Rural Sociology (5 hours). A comparative analysis of rural-urban social systems. Analysis of the decline of rural-urban differences and the development of interdependency among rural-urban subsystems.

RURAL SOCIOLOGY (continued)

RURL SOC 666 - Rural Poverty (5 hours). Evaluation of the factors which tend to create and perpetuate social and economic deprivation. The socio-economic conditions of poverty subgroups are analyzed in depth.

RURL SOC 688 - Social Impact Assessment of Domestic Development (5 hours). Discussion of concepts and methods associated with social impact assessment of planned change programs. Primary emphasis will be placed upon public development programs.

RURL SOC 744 - Rural Sociology Demography (5 hours). Application of demographic principles to rural communities, rural institutions and rural social problems with emphasis on population change and migration.

SOCIAL WORK

SOC WORK 570 - Interpretation of Social Welfare Information (3 hours). Examination of different kinds of social welfare data with a focus on content analysis; case study and descriptive information with a primary emphasis on interpretation.

SOC WORK 571 - Introduction to Research Methods in Social Work (5 hours). Science and society; research designs; measuring variables; data collection, processing and analysis; participation in research project is required.

SOC WORK 787 - Seminar on the Application of Experimental Designs to Social Work Research (3 hours). Evaluating the plausibility of findings from research using experimental designs as compared with the plausibility of findings from other designs when an experimental design was not feasible.

SOC WORK 920 - Seminar in Social Welfare Policies and Programs I (5 hours). Analysis and evaluation of policy formulation and implementation; utilization of an analytical model to study a matrix of conditions and issues in policy development.

SOC WORK 970 - Seminar in Social Work Research I (5 hours). Examination and evaluation of research designs and their purposes; basic methodology, construction of hypotheses, data collection, statistical methods.

SOCIOLOGY

SOCIOL 650 - Introduction to Quantitative Research Techniques in Sociology (5 hours). An introduction to the analysis of sociological data; measurement theory and techniques of interpretation; sampling procedures in sociological research and implications for inference and generalization.

SOCIOLOGY (continued)

SOCIOL 651 - Approaches to Sociological Inquiry (5 hours). Theory and practice in essentials of the research process; comparison of alternative approaches and design models; questionnaire construction, interview techniques, and related problems.

SOCIOL 706 - Experimental Research Methods (5 hours). Survey and analysis of research designs and statistical techniques permitting control and/or assessment of error variance in sociological research by experimental method.

SOCIOL 707 - Problems in Quantitative Analysis (5 hours). A survey of advanced problems in the multivariate analysis of sociological data; topics covered include elaboration and specification, causal inference in nonexperimental research and path analysis.

SOCIOL 752 - Principles and Techniques of Scale Construction (5 hours). Approaches and techniques in the development and testing of social measurement instruments.

SOCIOL 754 - Demographic Analysis (5 hours). An exposition of census data and vital statistics, demographic rates, life tables, cohort analysis, and similar elementary techniques and data sources in demography.

SOCIOL 756 - Migration and Social Mobility (5 hours). Theories and models of population mobility; determinants and consequences of the migration process; policy implications of rural-urban migration.

SOCIOL 791 - Sociological Methods of Community Analysis (5 hours). Methods, techniques, sources of data, and objectives of community analysis.

SOCIOL 846 - Seminar in the Demography of Urbanization (5 hours). An analysis of urban phenomena using demographic data and techniques; an analysis of the effect of urbanization on demographic processes.

STATISTICS

STAT 525 - Statistical Methods (5 hours). Basic concepts of probability and statistical inference; application to models involving binomial, Poisson, and normal distributions, and linear regression.

STAT 600 - Statistics Laboratory (1-5 hours). Experience is given the student in working with real data through association with current projects in the Statistics Laboratory.

STATISTICS (continued)

STAT 635 - Statistical Analysis of Time Series (3 hours). Time series models; estimation of the spectral density function; transformations of time series; prediction theory applications.

STAT 641 - Linear Models (3 hours). The general linear model for regression and experimental designs; properties of least square estimates; distribution of quadratic forms and the analysis of variance table.

STAT 651 - Survey Sampling Methods (3 hours). Sampling from finite populations, domains of study, stratification, ratio and regression estimates, systematic sampling, one- and two-stage cluster sampling.

STAT 655 - Multivariate Data Analysis (5 hours). Graphical analysis of multivariate procedures, clustering and classification procedures, multivariate normal proceedings, correlation and regression in multivariate analysis, modern data analytic techniques for multivariate data, applications.

STAT 656 - Applied Multivariate Analysis (5 hours). Multivariate statistical procedures specially related to the normal distribution multivariate analysis of variance, classification, principal components and elements of factor analysis, applications, nonparametric multivariate procedures.

STAT 661 - Applied Nonparametric Statistics (5 hours). Noncalculus treatment of nonparametric tests, confidence intervals, estimation; topics include one- and two-sample problems, one- and two-way analysis of variance, multiple comparisons, correlation.

STAT 665 - Discrete Data Analysis (4 hours). Introduces qualitative or categorical data analysis, contingency tables; cross-sectional, prospective, retrospective and controlled comparative trials; sample size determination, combining evidence, and misclassification errors.

STAT 671 - Simulation and Monte Carlo Techniques (5 hours). The use of digital computer program in simulating the operating characteristics of a complex system and in approximating solutions by random sampling; programming applications.

STAT 742 - Analysis of Variance (3 hours). Theory of the general linear model; least square estimates and properties, especially in non-full rank models; analysis of variance technique; factorial designs.

STAT 746 - Design and Analysis of Experiments (3 hours). A continuation of 742; various experimental designs; analysis of covariance, mixed and random models.

STATISTICS (continued)

STAT 751 - Survey Sampling Theory (4 hours). Theory of sampling from finite populations, simple random and unequal probability sampling, stratification, ratio and regression estimates, cluster sampling, recent developments.

STAT 755 - Multivariate Analysis I (3 hours). Multivariate normal distribution, Wishart distribution, Hotelling's T, multivariate analysis of variance, multiple correlation, roots of determinant equations, discriminant functions, and applications.

STAT 756 - Multivariate Analysis II (3 hours). Continuation of 755.

STAT 824 - Statistical Decision Theory I (3 hours). Introduction to the theory of games, statistical games, admissibility and completeness, complete class theorem, principles of sufficiency and invariance, sequential games.

DEPARTMENTS OFFERING QUANTITATIVES METHODS

Accounting

Agricultural Education

Business Administration: Finance

Business Administration: Management Science

Business Administration: Marketing

City and Regional Planning

Computer and Information Science

Economics

Educational Foundations and Research

Education for Exceptional Children

Geography

Hospital and Health Services Administration

Industrial and Systems Engineering

Labor and Human Resources

Medical Record Administration

Political Science

Psychology

Public Administration

Rural Sociology

Social Work

Sociology

Statistics

Appendix Two

SAMPLE MBA PROGRAM WITH MAJOR REQUIREMENT IN DECISION SCIENCES

Based on Requirements Detailed in

The 1979-80 WHARTON GRADUATE DIVISION COURSE GUIDE

Prepared By

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Advanced Study Center
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210
(Tel. #800-848-4815)

For Discussions Regarding

THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION

LEADERSHIP DEVELOPMENT PROGRAMS

(A 1980 Advanced Study Center Project)

(August 1980)

WHARTON SCHOOL MBA PROGRAM

DEPARTMENT OF DECISION SCIENCES
UNIVERSITY OF PENNSYLVANIA

Sample Program with Major Requirement in Decision Sciences

Management Core (6 Units)

- BA 800 Accounting
- BA 803 Management and Organizational Behavior
- BA 805 Economic Analysis and Policy (Microeconomics)
- BA 806 Economic Analysis and Public Policy
- BA 807 Quantitative Methods II
- BA 808 Statistical Analysis

Noncredit Skill Courses

- BA 814 Problem Solving Using the Computer
- BA 815 Quantitative Methods I
- BA 891 Oral Communication
- BA 892 Written Communication

Managerial Disciplines (4 Units)

- BA 713 Financial Analysis
- BA 812 Legal Aspects of Business
- BA 904 Management of Industrial Relations
- BA 905 Organizational Policy

Decision Science (9 Units)

- BA 650 Management Decision Analysis
- BA 651 Stochastic Decision Systems
- BA 655 Operational Planning and Control
- BA 659 Advanced Topics in Quantitative Methods
- BA 660 Management Information Systems
- BA 661 Systems Analysis, Design & Implementation
- BA 662 Information Systems for Functional Areas
- BA 664 Database Management
- BA 672 Model-Based Planning Systems

Based on MBA Requirements detailed in Wharton Graduate Division Course Guide 1979-1980

MANAGEMENT CORE

•BA800

Accounting

Associate Professor Brennan

Fall, Spring, Summer

GENERAL DESCRIPTION:

The role of accounting is the accumulation, analysis and presentation of relevant financial data of an enterprise to serve the needs of decision makers. The provision of multiple-purpose information to serve the needs of owners, creditors and many other types of interested parties outside the film's management is referred to as financial accounting. Providing data for the internal needs of management is referred to as managerial accounting. The objective of this course is to introduce the student to the basic concepts, standards and practices of financial reporting.

The first one-third of the course is devoted to financial accounting: the basic financial reports or statements; analysis and recording of business transactions; underlying concepts and procedures; the preparation of the statements.

The middle one-third of the course is devoted to a more detailed study of some aspects of financial accounting that have wide-spread significance: inventors; long-term productive assets; bonds and other liabilities; stockholders' equity; the statement of changes in financial position.

The last part of the course is concerned with managerial accounting, which is oriented toward internal control by management: accounting for production costs; cost-volume-profit relationships; special problems of overhead costs; standard costs.

COURSE FORMAT:

All assignments in preparation for class consist of text readings and the solving of related problem materials. Teaching method used in class sessions is the discussion of the topical area, with the assigned problems serving as a means of coordinating the discussion.

COURSE REQUIREMENTS:

There are two midterm examinations and a final examination. A midterm examination is scheduled at the end of each of the first two segments of the course, emphasizing those parts of the course, and the final examination emphasizes the last part of the course.

PREREQUISITES:

None.

COURSE MATERIALS:

Davidson, Stickney and Well, Financial Accounting: An Introduction to Concepts, Methods and Uses, Dryden Press, 1979, 2nd edition.

Louderback and Dominiak, Managerial Accounting. Wadsworth Publishing Co., 1978.

•BA803
Management and Organizational Behavior
Professor Schein and Staff
Fall, Spring

GENERAL DESCRIPTION:
Management and Organizational Behavior is a core course designed to provide basic grounding in three major areas of management: 1. behavior of individuals and small groups; 2. design and change of organization structure; 3. strategy making, planning and control processes. The course content will be based on concepts from successful managerial practice, relevant theories and empirical research. The purpose is to provide knowledge concerning significant managerial choices of compensation schemes, organization forms, product/market strategy, etc. The basic grounding is to provide acceptable levels of competence for those students taking only one Management course and a foundation for more advanced Management courses for those continuing or majoring in Management.

Management and Organization Behavior is a multi-section course. As such, each section will follow the same syllabus, use the same text, use the same cases and take a common final exam. On the other hand, to take advantage of the various unique skills of the faculty, each one may use various teaching techniques to transmit the same content. In addition, each faculty member may add various articles or cases that may be needed. Students are asked to purchase a fee card to cover these materials.

COURSE FORMAT:
Case study and lecture.

COURSE REQUIREMENTS:
Case study papers, presentations, and exams subject ot individual instructor.

PREREQUISITES:
None.

COURSE MATERIALS:
Bulk packet to be obtained from Wharton Duplicating.
Hampton, Summer and Webber, Organizational Behavior and the Practice of Management, 1978.

•BA805
Economic Analysis and Policy (Microeconomics)
Professor Phillips
Fall, Spring, Summer

GENERAL DESCRIPTION:
This course deals with theory of the consumer, theory of the firm, organization of competitive markets, monopoly, market power, government regulation and taxation, social choice, public goods and externalities, and public policy. This course is taught at an intermediate level tailored to MBA candidates. Special sections emphasize particular applications.

COURSE FORMAT:
Lecture.

COURSE REQUIREMENTS:
Solving problems alone and with groups of students. Exams by individual section.

PREREQUISITES:
None. The student who has never previously studied economics might find it useful to skim through an introductory economics text such as Samuelson's Economics or Mansfield's Economics. The level of mathematics used assumes that the student has already successfully completed the Wharton elementary calculus requirement (either by a waiver or by BA815). Students who majored in economics as undergraduates (or who have taken a large number of economics courses already) should not be taking this course. They are encouraged to take the waiver exam or substitute with another course.

COURSE MATERIALS:
The principal text used in the course will be Microeconomics (second edition) by Edwin Mansfield or an equivalent text. Large segments will also be read from F.M. Scherer's Industrial Market Structure and Economic Performance. These books are available in the bookstore. Several copies have been placed on reserve in Lippincott Library. The non-text readings have largely been accumulated in a bulk pack for each section. The bulk pack is available from the Wharton Duplicating Center, Dietrich W-33. Outside readings which are not in the bulk pack are on reserve in Lippincott.

•BA806
Economic Analysis and Public Policy
Associate Professor Santomero and Staff
Fall, Spring, Summer

GENERAL DESCRIPTION:
This is a course required of all students, except those who--having prior training in macroeconomics, money and banking and stabilization policy at an intermediate/advanced level--obtain a waiver either by credentials or by passing an examination. (The waiver examination is usually held in early September and January). The purpose of BA806 is to train the student to think systematically about macroeconomic policy, to be able to evaluate the economic environment within which business/government decisions are made. The course emphasizes the use of theory to understand the operation and impact of policy. Specifically, the course studies the determinants of the level of national income and of interest rates; the supply of money; the analysis of inflation and of the balance of payments; and the formulation of the operation and working of stabilization policies.

COURSE FORMAT:
Classroom lectures and discussion. The balance may be expected to vary slightly, reflecting the preferences of the individual instructors.

COURSE REQUIREMENTS:
Two midterm examinations and one final examination are given in common for all instructors. Individual instructors may supplement these with other assignments.

PREREQUISITES:
1. BA815 or equivalent.
2. No formal prerequisite of prior training in economics is stipulated. However, students with no college level course work in economics frequently experience considerable difficulty, since the subject matters covered in BA806 are extensive, the coverage is at an intermediate/advanced level, and topics are developed rather rapidly. Students with no prior training in economics are urged to remedy this, minimally, by private reading of a basic introductory text. (Those by McConnell, Mansfield or Samuelson are particularly recommended for self study).

COURSE MATERIALS:
These vary from term to term.

•BA807
Quantitative Methods II
Associate Professor Hershey and Staff
Fall, Spring, Summer

GENERAL DESCRIPTION:
This core course introduces the basic concepts and methods of "Operations Research" or "Management Science" and their application to the analyses of management decision problems. The focus of the course is on those methods of decision analysis which have proven most useful in a variety of private and public contexts. The general content of the course includes mathematical modeling, decision analysis under (assumed) certainty, constrained optimization, and decision analysis under uncertainty. This is reflected in such specific topics as inventory analysis, linear programming, sensitivity analysis, probability theory, decision trees, and simulation.

COURSE ALTERNATIVES:
The course is designed for students with limited quantitive backgrounds. Students with quantitative training or experience (e.g. in engineering, science, mathematics, etc.) are urged to consider substituting a more advanced course which will offer a better educational experience.

COURSE FORMAT:
Class sessions will be conducted as a mixture of lecture and discussion, making use of some case studies and problem assignments. All sections will cover the same basic material, but may have minor variations in emphasis. A special health care section is taught in the fall using a number of cases and problems drawn from the health industry. Students who are not Health Care Administration majors need special permission from the Decision Sciences Department to enroll for this section.

The course will meet for an introductory session on the first day of classes. This will provide an opportunity for all entering students to discuss their course selections and substitution options with their instructors before the drop and add period.

COURSE REQUIREMENTS:
A common midterm and final examination are given to all sections, as is a computer-based case project. Problem assignments are due weekly to help the student assess his or her comprehension of the material.

PREREQUISITES:
BA815--Quantitative Methods I. (The two can be taken concurrently only with special permission.)

COURSE MATERIALS:
Textbooks to be determined.
(Bulk packet readings from Wharton Duplicating (W-33 DH).

•BA808
Statistical Analysis for Management
Professor Hamburg and Staff
Fall, Spring

GENERAL DESCRIPTION:
Probabilistic models are developed in this course for decision making and inference in the presence of uncertainty. The calculus of probability is developed and is illustrated by such discrete random variables as the binomial, Poisson, and hypergeometric. Among continuous random variables particular attention is given to the normal distribution because of its importance in classical statistical methods. Sampling procedures are treated, and methods are developed for making inferences about mean values, measures of dispersion, and proportions from samples. Chi-squared tests of goodness of fit and independence are developed. The relationships between variables are investigated by simple linear correlation and regression, and extensions are given to multiple regression analysis and analysis of variance for several predictor variables. The course is designed to develop critical judgment and to foster managerial decision-making ability using quantitative tools.

COURSE FORMAT:
Primarily lecture, recitation class and discussion format.

COURSE REQUIREMENTS:
The student is required to carry out a multiple regression analysis for several predictor variables using the computer assigned problems; two midterm examinations; a final examination.

PREREQUISITES:
A working knowledge of differential and integral calculus.

COURSE MATERIALS:
Hamburg, Morris, Statistical Analysis for Decision Making, 2nd edition, Harcourt Brace Jovanovich, 1977.

NONCREDIT SKILLS COURSES

•BA814
Problem Solving Using the Computer
Director of the Wharton Computer Center and Staff
Fall, Spring, Winter, Summer

GENERAL DESCRIPTION:
The MBA program is geared toward producing managers. The tools available to a modern manager include basic computer skills; it is the goal of the BA814 course to provide students with those skills. The course has two objectives: 1. To develop in prospective managers an ability to recognize certain applications in which a computer can assist in decision-making; 2. To develop in those managers an understanding of how to apply the computer to such a situation.

The BA814 course is made up of the following phases: 1. An orientation to the Wharton Computer Center's DECsystem-1090, to teach students how to use the computer effectively in a timesharing environment; the knowledge gained here will be utilized later to complete assignments from various courses in the MBA curriculum; 2. Development of a working knowledge of APL, a powerful interactive computer language; programming exercises will provide potential managers with a basic understanding of how the computer can assist them in solving business problems.

COURSE FORMAT:
Series of lectures to complement the material presented in the text; problem exercises and quizzes to test understanding. Final project incorporates different aspects of course material.

COURSE REQUIREMENTS:
A series of problem exercises using the APL language to the DEC-10, three quizzes and a final project.

PREREQUISITES:
None
Students are encouraged to complete the 814 requirement in the summer or winter terms.

COURSE MATERIALS:
Bulk package containing 15 chapters of course text, problem assignments; glossary of terms and other supplementary material.

•BA815
Quantitative Methods I (Remedial Calculus)
Staff
Fall, Midwinter Break, Spring, Summer (latter half of August)

GENERAL DESCRIPTION:
This course is designed to provide an adequate mathematical background for subsequent courses in operations research, statistics and economics.

The common functions of applied mathematics are studied by the methods of calculus, with emphasis throughout on the use of graphical and intuitive reasoning. The derivative is visualized as the instantaneous rate of change of a function; it is used in the construction of graphs and in the solution of optimization problems. Integration is introduced as a summing process for functions. The necessary computational techniques are presented, but the development of an intuitive understanding and appreciation of the calculus is the primary goal.

COURSE FORMAT:
Lecture and discussion.

COURSE REQUIREMENTS:
A final examination, which also serves as the BA815 waiver examination. Problems are suggested but nor required. A midterm quiz to gauge progress is typically offered. A waiver examination is also given midway through the fall and spring semesters for those who are ready to complete the requirement at that time.

PREREQUISITES:
Material which will be reviewed at the start of BA815 but which the student should know before taking the course includes: linear functions, slopes of lines, logarithms, simultaneous equations, and algebraic manipulation of fractions and quadratic functions.

COURSE MATERIALS:
Freund, John E., College Mathematics with Business Applications, 2nd edition, Prentice-Hall Englewood Cliffs, N.J., 1975.

•BA891
Oral Communication
Lecturer Wolford
Fall, Spring

GENERAL DESCRIPTION:
All MBA candidates are required to demonstrate proficiency in oral and written communication.

To satisfy the oral communication requirement (BA891), students may elect to either be evaluated in one of the designated courses requiring oral presentations (e.g., certain sections of BA801, BA803, BA650, BA660, BA819, BA842, and others) or take an oral communication workshop 1-1/2 hours a week for five weeks.

General topics covered in oral communication workshops include: Persuasion; Personality projection; Methods of holding audience attention; Visual aids; Organization; Delivery.

In addition to these workshops, the Communication Program offers special seminars in running meetings, media relations and other pertinent topics.

SECTIONS:
BA891 is free and not given for credit. Students may register by coming to the Communication Program office, E-13 Dietrich Hall.

•BA892
Written Communication
Lecturer Robbins
Fall, Spring

GENERAL DESCRIPTION:
To satisfy the written communication requirement (BA892) students may elect either to be evaluated by the communications staff through writing assignments in BA803 or through other courses requiring a significant amount of writing, or to take one of the writing workshops offered throughout the year.

General topics include: 1. Style vs. content; 2. Principles of revision; 3. Letters, memos, resumes; 4. Research techniques; 5. Editing; 6. Personal writing problems.

SECTIONS:
Evaluation through Coursework. In order to satisfy the written communication requirement, students taking BA803 will automatically registered for BA892.

Written Communication Workshop. You may also register for BA892 by signing up for any section of the Writing Workshops. Choose a section of BA892 from course listings; be sure to note dates and times since sections vary.

MANAGERIAL DISCIPLINES

BA713
Financial Analysis
Adjunct Associate Professor Percival and Staff
Fall, Spring, Summer

GENERAL DESCRIPTION:
This course serves as an introduction to Business Finance (Corporate Financial Management and Investments) for both majors and non-majors. The course develops tools, concepts and relationships needed for many upper level major courses and gives a general overview of financial management needs by non-majors. Topics covered include: analysis and projection of financial statements, breakeven analysis, operating leverage, financial leverage, capital budgeting, sources of capital, capital structure, cost of capital, valuation, investment decision making under uncertainty, portfolio analysis and capital asset pricing.

COURSE FORMAT:
Primarily lecture.

COURSE REQUIREMENTS:
Midterm exam and final. Additional requirements differ from section to section; include cases, homework problems, company analysis.

PREREQUISITES:
BA800 prerequisite; BA808 prerequisite or concurrent.

COURSE MATERIALS:
Brigham, and Weston, Managerial Finance. Brigham, and Johnson, Issues in Managerial Finance. Bulk pack of readings.

•BA904
Management of Industrial Relations
Associate Professor Perry
Fall, Spring

GENERAL DESCRIPTION:
This course is designed to provide students with an understanding of the basic economic and institutional forces which influence management decisions on the terms and conditions of employment for its work force. Primary emphasis is placed on the procedural and substantive constraints imposed on management by labor unions and collective bargaining in order to highlight the sources of conflict and role of bargaining power in the determination of wages, hours, and other terms and conditions of employment. Attention is also given to the impact of the growing system of government regulation of employment policies and practices on management, unions, and collective bargaining.

COURSE FORMAT:
Classes are a combination of lecture and discussion on specific topics. Discussion of current events is encouraged at all times. The course concludes with a mock contract negotiations for which the class is divided into sets of union and mangement teams.

PREREQUISITES:
None.

COURSE MATERIALS:
The basic texts for the course are:
Sloane and Whitney, Labor Relations.
Rees, The Economic of Trade Unions.
In addition, outside readings are required which are on reserve in both Lippincott Library and the Industrial Research Unit's Library.

•BA905
Organizational Policy
Professor Ozbekhan
Fall, Spring

GENERAL DESCRIPTION:
This course is an attempt to inquire in depth into the current and emerging practices of decision making, management strategies and policy formulation in the planning-mode. Its approach to the subject could be called "dialectical": the perspective being that of general managers at all levels, as well as that of an outside consultant who has been invited to help them improve the decision/action processes of the organization.

The substantive argument which runs through the course is built around a generalized planning paradigm grounded in system-theoretic approaches which allow the student to proceed from the initial problem structuring phase, through normative, stategic and organizational planning, to implementation. Emphasis is on the subtle, yet powerful, interactions that exist between objectives, strategies, policies and organization design--in environments that are changing not only rapidly, but in ways that make them increasingly more complex.

Newly developed analytical and synthesizing methods and techniques--Dissonance Analysis, Idealization, Scenario Construction, Objectives and Goals Derivation, etc.--which are getting to be used in the most advanced planned-decision/action processes are elaborated in some detail.

COURSE FORMAT:
The basic format of the course if the lecture, because the classes are usually rather larger. However, the instructor makes an effort to conduct the lectures with a great deal of dialogue thrown in.

COURSE REQUIREMENTS:
Requirements change from semester to semester, depending on the instructor's assessment of the temper of the class as a whole. This means that sometimes a short individual midterm paper might be required. This is, generally speaking, "participatively" determined.

The principal requirement is a final paper at the end of the term.

PREREQUISITES:
BA803, and also a deep interest in the realities of our changing world. Also a capacity of being able to think creatively in terms of "design."

COURSE MATERIALS:
Readings in planning theory and practice; in systems thinking; in policy analysis. (A Reading List will be provided.)

BA812
Legal Aspects of Commercial Transactions (of Business)
Associate Professors Dunfee and Shurtz, Lecturer Bauer
Fall, Spring, Summer

GENERAL DESCRIPTION:
This course covers the basic substantive law of commercial transactions. Legal topics covered include contract law, agency law, sales law, and the law of negotiable instruments. Recent developments and business applications are emphasized.

COURSE FORMAT:
Lecture and discussion with coverage of legal cases and legal problems based on cases.

COURSE REQUIREMENTS:
Students are expected to have read the case excerpts assigned for each class. A midterm and a final exam will be given.

PREREQUISITES:
None. It is suggested that students who had as undergraduates a basic business law course take a graduate Legal Studies course other than BA812. (One alternative of general interest is BA952. A description for this Legal Studies option appears on the next page).

COURSE MATERIALS:
Depending on the instructor, either Lusk, et al., Business Law Principles and Cases (Richard D. Irwin, 1978) or Smith and Roberson, Business Law (West) is used.

•BA952
Legal Aspects of the Management Process
Professor Kempin
Spring

GENERAL DESCRIPTION:
The course is a study of the partnership, limited partnership, and, for most of the course, the corporation, from the vantage point of staff and line officers. The objectives of the course are to give the student: 1. An understanding of the place of the corporation in society, taking into account its history and development; 2. Knowledge of the principles of legal authority that enable one to cause the organization to be bound to third persons in contract or in tort; 3. An overview of the legal duties of business managers to their various constituencies: the organization itself, shareholders, creditors, employees, customers, and the general public; 4. An understanding of the application of criminal law to organizations and their managers; 5. An opportunity to compare the intended effects of statutes and legal principles with practicalities of the management process. Topics include the history of business organizations; principles of authority, partnership management, crimes, torts, and dissolution; limited partnerships; the theories of the corporation; limited liability; power of stockholders, directors and officers; corporate torts and crimes; dividends; management's duties to the corporation, shareholders, creditors, and to the public.

COURSE FORMAT:
Discussion of cases and problems.

COURSE REQUIREMENTS:
One intraterm exam and one final.

PREREQUISITES:
None.

COURSE MATERIALS:
Kempin and Wiesen, Legal Aspects of the Management Process, West Publishing Company, 2nd edition, 1976.

Decision Sciences

BA650

Management Decision Analysis

Associate Professor Fisher, Assistant Professor Elam, and Staff

Fall, Spring

GENERAL DESCRIPTION:

BA650 is a quantitative methods course oriented around case studies involving resource allocation, decision analysis and simulation. The course is particularly appropriate for students with some quantitative background or for those interested in an extensive and practical treatment of management decision making methods. Methodologies for structuring analysis will be presented for problems in both the public and private sectors.

This course can be taken as an alternative to the core course BA807 by students who have a reasonable level of confidence and maturity in dealing with quantitative problems and methods.

COURSE FORMAT:

As part of the course the class will discuss published articles and cases dealing with decision problems in a variety of managerial contexts, ex.g. banking, manufacturing, process industries, utilities and services sector systems. For purposes of case analysis the class will be divided into teams and each team will lead the discussion on one or more cases.

COURSE REQUIREMENTS:

Midterm and final examinations, written and oral group presentation of a case.

PREREQUISITES:

Confidence and maturity in dealing with quantitative methods and problems. Those with undergraduate majors in math, science, engineering, economics or business should be well qualified.

COURSE MATERIALS:

Required Materials:

Bulk Packet, a packet of text and case materials available from Wharton Duplicating Center.

Text:

Eppen, G. and F. J. Gould, Management Science in Practice.

Reserve Materials (Lippincott Library):

Raiffa, Howard, Decision Analysis, Addison-Wesley, 1968.

Hillier, F.S. and Lieberman, G.J., Introduction to Operations Research, Holden-Day, 1974, 2nd edition.

Wagnet, Harvey M., Principles of Operations Research, Englewood Cliffs, Prentice-Hall, 1969.

Kim, C., Quantitative Analysis for Managerial Decision, Addison-Wesley, 1976

BA651
Stochastic Decision Systems
Assistant Professor Prastacos
Fall

GENERAL DESCRIPTION:
Uncertainty has a decisive influence on the shaping of business decisions. Almost every phase of consumer and firm behavior is affected by it.

This course is a methodology course dealing with problems amd models for decison making under uncertainty. The course will be directed toward illustrating the most important stochastic models, and their application to the functional areas of business. Material to be covered includes the topics: static analysis, dynamic programming, Markovian decison processes and simulation.

COURSE FORMAT:
Lectures, cases, problem-solving exercises.

COURSE REQUIREMENTS:
Exams.

PREREQUISITES:
BA808, BA650

COURSE MATERIALS:
Hillier & Lieberman, Operations Research, 2nd. ed., Holden-Day.

Elton & Gruber, Finance as a Dynamic Process, Prentice-Hall.

DeGroot, Optimal Statistical Decision, McGraw-Hill, 1970.

Bulk-packet.

•BA655
Operations Planning and Control
Assistant Professor Cohen and Staff
Fall, Spring

GENERAL DESCRIPTION:
This course is concerned with the analysis of operational decision making in a variety of managerial contexts. Topics covered include: process analysis, inventory control, detailed and project scheduling, aggregate planning, capacity management, facilities planning, logistics and distribution systems, technology planning and operation strategy. The course considers basic analytic tools required for these topics through a review of relevant models and studies. In addition, cases are considered which both illustrate the relevant tradeoffs and explore the impact of operational decisions throughout the organization medium term tactical decisions to long term strategic decisions is carried out.

COURSE FORMAT:
A mixture of cases, lectures, group presentations, site visits.

COURSE REQUIREMENTS:
A variety of cases and homework assignments (both individual and group) and a final exam.

PREREQUISITES:
BA807, BA650 or equivalent.

COURSE MATERIALS:
Operations Management: Text and Cases by Marshall et al.
Bulk Packet.

•BA659
Advanced Topics in Quantitative Methods and Operations Mgmt.
Assistant Professor Cohen
Spring

GENERAL DESCRIPTION:
The specific content of this course varies from semester to semester, depending on student and faculty interests. The current topic is Applied Dynamic Stochastic Systems which reviews pertinent theoretical foundations of dynamic programming, stochastic control and Markov Decision Processes with a view toward their application in management science. Topics to be covered include: discrete time stochastic reward systems with particular emphasis on stochastic inventory and production systems. Continuous-time formulations of stochastic control problems and semi-Markov decision processes will also be pursued. The main thrust of the course will be to explore the theory and more important applications of dynamic stochatic systems to production, finance, and marketing decision problems.

COURSE FORMAT:
Lecture, student presentation.

COURSE REQUIREMENTS:
Course requirements include the lectures, some exercises, and a research paper. Auditors welcome.

PREREQUISITES:
A reasonable level of mathematical maturity will be presupposed. Explicit prerequisites are 600-I, 600-II (or equivalent) and real analysis. Exposure to OR606 will not be assumed.

COURSE MATERIALS:
A bulk packet consisting of recent articles, case studies, and text materials.

• BA660
Management Information Systems
Associate Professor Morgan and Staff
Fall, Spring, Summer

GENERAL DESCRIPTION:
BA660 is a full credit replacement for BA801 and should be taken by those students who expect to take further courses in Decision Sciences. The course considers the computer its history, components and architecture; file organization techniques and database management systems; the management use of computers for data processing, planning and decision support; and the process of systems analysis and design whereby technology is brought to bear on the problems of management.

COURSE FORMAT:
The course will be presented through lectures, problem assignments, cases and class discussion. There will be approximately five problem sets assigned throughout the semester.

COURSE REQUIREMENTS:
A midterm exam will be given. In lieu of a final, a research paper on a selected I/S topic will be required. In addition, a final case will be distributed during the second half of the semester and assigned to teams. This case will require a synthesis of all material presented during the course. Both a written and an oral presentation will be required.

PREREQUISITES:
Students must have completed the BA814 programming requirement prior to entering BA660.

COURSE MATERIALS:
Textbooks:
Senn, Information Systems in Management.
Kenn and Scott-Morton, Decision Support Systems.
Bulk Pack, available from Wharton Duplicating Center.

•BA661
Systems Analysis, Design and Implementation
Assistant Professor Hackathorn
Fall

GENERAL DESCRIPTION:
BA661 is an application-oriented project course in systems analysis, design and implementation. We recognize the need for information systems that effectively meet the current needs of an organization, are flexible and thus can meet future unanticipated requirements, and operate efficiently. We note that all too often information systems are ill-conceived and poorly implemented. The goals of this course include: 1. Training managers in the design, capabilities and limitations of information systems; 2. Beginning the training of professional systems analysts; 3. Providing future managers and systems builders with techniques for facilitating the project implementation process.

COURSE FORMAT:
The course is divided into four major units. The first three comprise readings and lectures in the areas of analysis, design, and system implementation. The final unit will include student presentations of cases and assigned study projects undertaken for corporate "clients."

COURSE REQUIREMENTS:
There will be five small exercises assigned as indicated in the syllabus; these are designed to strengthen the student's understanding of concepts covered in the course. A programming exercise in ASAP will also be assigned. Finally, there will be two projects assigned to integrate the material presented, a case prepared for class discussion and the study project. The majority of these exercises will be done as group projects. There will be no examinations in the course.

COURSE MATERIALS:
There is no required text for the course. There is a bulk pack available from Wharton Duplicating that will be required. There is also an ASAP 2.0 System Reference Manual that should be purchased by each group. The following additional texts are recommended.
Brooks, The Mythical Man Month.
Burch and Hod, A Case Workbook for Systems Analysis.
Weinberg, The Psychology of Computer Programming.

•BA662
Information Systems for Functional Areas
Staff
Fall, Spring

GENERAL DESCRIPTION:
This course deals with the ways in which general and functional managers can exert effective management controls over the applications of computers and information systems in their divisions or departments. Two principal issues are addressed in the course: systems analysis and design, and the management of an MIS effort.

Systems analysis and design consists of (1) identifying the imputs (data) and outputs (management reports) of an information system; (2) determining how the imputs are to be transformed into outputs (e.g., retrieval of a data element, aggregation of several data elements, statistical analysis, etc.); and (3) determining the important characteristics of the information processing system, such as record content and file organization.

The management of MIS effort will be examined in the second part of the course. Readings and case studies will be used to illustrate the problems faced by an MIS manager--for example, preparing an MIS plan, implementing the plan, selecting computer hardware, designing computer software, managing for working with computer professionals, and designing a "total" or "integrated" MIS. The purpose of this part of the course is to prepare the student to supervise and work with MIS managers.

COURSE FORMAT:
The course will consist of a set of reading assignments and case studies that illustrate the applications of computers and MIS in a variety of organizations--for example, a manufacturing department, a marketing department, a comptroller's office, a project management staff, a personnel department, a corporate headquarters, etc.

COURSE REQUIREMENTS:
The final grade in the course will depend on performance on the cases and on a take-home final examination. (This course, like most of the information systems courses, has been renumbered. It was formerly DS222).

PREREQUISITES:
Any introductory information systems courses (BA660, etc.)

COURSE MATERIALS:
McFarlan, Warren F., et al., Information Systems Administration, Holt, Rinehart, & Winston, 1973
Price, Thomas R., Information Systems for Management Planning and Control, 3rd ed., Irwin, 1975
"Merrill Lynch, Pierce, Fenner and Smith," (Parts A and B), and "The Sujakan Company," available in a bulk pack from the Wharton Duplicating Center.

•BA664
Database Management
Assistant Professor Clemons
Spring

GENERAL DESCRIPTION:
The increased use of computers by organizations, the recent advances in data management technology, and the growing realization that various units within the organization depend on common information, is causing dramatic growth in the use of database management systems. This course will examine various theories of data, including the hierarchical model, the relational model, the entity-set model and the network model. Implementations of database management systems will be considered, with a focus on the SEED system. The course also examines topics related to the application of database management systems, including database design, cost trade-offs, and the implementation of application programs. Associated costs and efficiencies will be an important consideration at all levels. Students will have an opportunity to use a recent advance in the technology, Micro-SEED, a microprocessor-based database management system.

COURSE FORMAT:
We will hold an all day (10AM to 4PM) DBMS marathon. This all day session will serve to introduce students to the operation and use of SEED and Micro-SEED. Various on--line demonstrations will be given, and students will then have the opportunity to design and implement databases of their own on-the-spot. DBMS experts will be available as consultants. Several regularly scheduled sessions have been cancelled to compensate for the time used for the marathon.

COURSE REQUIREMENT:
All students will be required to complete a project involving the implementation of an extension to or application of SEED. There will be four short exercises. In addition, there will be a midterm and a final examination.

PREREQUISITES:
DS11, DS12, or BA660, or permission of the instructor. Familiarity with the DEC10 is required as is experience in either COBOL or FORTRAN. Either of these languages may be used for examples in class, and students will be asked to complete programming assignments using one of the languages.

COURSE MATERIALS:
ACM Computing Surveys, (Special Issue: Data-Base Management Systems) Vol. 8, March 1976.
Gerritson, Rob, SEED Reference Manual, International Data Base Systems, Inc., 1978.
Martin, James, Computer Data-Base Organization, Prentice-Hall, 1975.

Bulk Pack, available from Wharton Duplicating Center.

Recommended (not required):
Date, C.J., An Introduction to Database Systems, Addison-Wesley, Second Edition, 1977. This text has excellent material on IMS and the Relational Model. Purchase it if you have found in the past that you can understand concepts better if you get them from more than once source, if your goal is to establish a good DBMS reference library, or if you have an interest in some of the more theoretical aspects of DBMS.

BA672
Model-Based Planning Systems
Staff
Spring

GENERAL DESCRIPTION:
The purpose of this course is to examine the ways in which managers responsible for the preparation and implementation of plans may make use of information systems containing decision models--such as financial models, logistical models, marketing models, econometric models, etc. Two principal issues are addressed in this course; (1) the ways in which model-based systems are used (and misused) in corporate and government planning, and (2) the critical decisions that must be made during the life cycles of these systems if they are to be successful. In other words, the course will examine two types of management decisions--those that are made with the aid of model-based systems (for example, capital investment decisions made with the assistance of a marketing model) and those that affect the development of the system (for example, the go/no-go decision made at the start of a system development effort or a decision to modify or terminate an ongoing system).

COURSE FORMAT:
The principal pedagogical method of this course is the case method. Approximately half of the class session will be devoted to detailed examinations of case studies that describe attempts to design and implement model-based planning systems in public and private organizations. The remainder of the classes will be devoted to lecture/discussions on such topics as corporate modeling, sensitivity analysis, data management systems, interactive systems, etc.

COURSE REQUIREMENTS:
The final grade for the course will depend on performance on the case discussions in the class and on written case assignments which will be prepared by teams of three or four students.

PREREQUISITES:
The prerequisites for the course are: (1) BA814 or equivalent; (2) an introductory computer course such as DS200 or BA660; and (3) an introductory course on modeling techniques such as BA807, BA902, or BA650. No mathematical analysis or computer programming will be done in this course, but the student should be familiar with the capabilities and limitations of models and computers at the introductory level covered in the prerequisite courses.

COURSE MATERIALS:
All cases and reading assignments are found in bulk package and are available from the Wharton Duplicating Center.

Appendix Three

MASTER OF ARTS PROGRAM IN HUMAN RESOURCES AND MANPOWER DEVELOPMENT

Based on Information Provided In

MASTER'S DEGREE PROGRAMS IN PROFESSIONAL STUDIES 1979-80 and 1980-81

GRADUATE SCHOOL OF MANAGEMENT AND URBAN PROFESSIONS

NEW SCHOOL FOR SOCIAL RESEARCH

Prepared By

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For Discussions Regarding

THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION LEADERSHIP DEVELOPMENT PROGRAMS

(A 1980 Advanced Study Center Project)

(August 1980)

NEW SCHOOL FOR SOCIAL RESEARCH

(Institutional Statements)

The New School for Social Research is an innovative urban university which evolved out of a deep commitment to meeting the intellectual and professional needs of mature citizens. Since its inception in 1919, it has been recognized throughout the world as a pioneering educational institution. The vision of the founders was to create an institution "honestly free" of narrow academic traditionalism which would dare to think creatively about the changes occurring in social, political and economic conditions.

An early achievement of The New School was the establishment of the University-in-Exile. This institution became the home of some of the foremost intellectuals of Europe during the 1930's and 1940's--men and women who were driven from their universities or made refugees by the war. The legacy of the University-in-Exile today is The New School's Graduate Faculty of Political and Social Sciences which offers Master of Arts and Doctor of Philosophy degrees in anthropology, economics, philosophy, political science, psychology and sociology and a Master of Arts in Liberal Studies.

The 1960's brought a new innovative response by The New School to the prevailing educational urban turmoil. This was the establishment of the Center for New York City Affairs to focus attention on problems of the New York Metropolitan area. During its 14-year existence, the Center has evolved into a research and study institution of national importance.

In 1970 the Center branched out in a new direction by offering a graduate degree program in Urban Affairs and Policy Analysis. Its success led to the creation of additional management-oriented programs of professional education and to the establishment of a fullfledged Graduate School of Management and Urban Professions.

GRADUATE SCHOOL OF MANAGEMENT
AND URBAN PROFESSIONS

(Institutional Statements)

The Graduate School of Management and Urban Professions is one of the four major divisions of the New School for Social Research. Located in New York City, the greatest urban education center in the world, the Graduate School of Management and Urban Professions offers students unusual opportunities to prepare for careers in management and policy analysis in a variety of urban professions.

The School offers two series of graduate degree programs--Career Entry programs described in this bulletin and Mid-career programs described in individual brochures.

The career entry programs have been designed for students who are embarking on their professional career or who are changing career and have had no significant experience in their new choice. They are intended primarily for students wishing to pursue their studies on a full-time basis. Most courses in the career entry programs are given in the daytime.

In the 1979-80 and 1980-81 academic years, the School will offer five career entry programs leading to a Master's degree:

Urban Affairs and Policy Analysis
Gerontological Services Administration
Health Services Administration
Human Resources and Manpower Development
Tourism and Travel Administration

The programs of the Graduate School constitute a response to the growing need for managerial competence in urban institutions. Leaders in government, corporate and nonprofit enterprises are called upon to cope with increasingly difficult problems--worldwide inflation and highly sophisticated technology. The interaction of such developments on already complex societal problems has highlighted the importance of analytically-trained management personnel.

MASTER OF ARTS DEGREE
HUMAN RESOURCES AND MANPOWER DEVELOPMENT

(Institutional Statements)

Human Resources and Manpower Development offers the analytical and conceptual tools most useful to the practicing professional in personnel management, manpower planning, training and development, and labor relations. Through electives students can concentrate in one of these mainstreams.

Career opportunities in the field of personnel management have undergone a large expansion over the past decade, not only in the number of available positions, but in the scope of responsibility, compensation and prestige. As the profession has grown, its functions have become more sophisticated and complex. Business enterprises are turning to personnel executives in ever-growing numbers to staff the top echelons of management.

Meanwhile, the large-scale commitment of government to urban planning, reducing unemployment, and attacking the causes of poverty has resulted in many new positions in manpower training and development. For the public sector the goals of manpower development are to analyze the labor market, generate job opportunities, and provide occupational training and placement for the unskilled and the unemployed.

Students in the Human Resources and Manpower Development program will gain experience in the salient skills of manpower development: planning, administration, training, counseling, and placement. They will also master the different dimensions of human resources management: recruitment and selection, compensation, pension and benefits management, equal employment opportunity and affirmative action, performance evaluation, labor relations, and organizational behavior. They will become acquainted with the structure of work. They will learn how to create and implement personnel training programs, prepare budgets and funding proposals, generate long-range plans, and evaluate programs.

Students who complete a series of six courses in Labor Relations will be eligible for a Labor Relations Certificate, a program approved by the State Education Department.

HUMAN RESOURCES AND MANPOWER DEVELOPMENT
NEW SCHOOL FOR SOCIAL RESEARCH

(Sample MA Program in HRMD)

Semester One

Core Course/LAB101	Laboratory in Issue Analysis
Core Course/MET201	Statistical Methods
Core Course/MGT401	Organizational Behavior & Small Group Theory
Major/MPR301	Introduction to Field of HRMP

Semester Two

Core Course/LAB201	Laboratory in Program Assessment Design
Core Course/MET202	Analytic Methods for Decision Making
Core Course/MGT214	Economic Principles for Managers
ELECTIVE/HRMP	(Could be Q.M. Elective)

Summer

FIELD WORK/(Noncredit Experience in NY Metropolitan Area)

Semester Three

Core Course/MGT403	Mgnt. Uses of Accounting & Budget Information
Major/MPR302	Labor Markets and the U.S. Economy
Major/MPR303	Sociology of Work
ELECTIVE/HRMP	(Could be Q.M. Elective)

Semester Four

Core Course/MGT404	Management Uses of Computer
ELECTIVES/HRMP	(Select 3 Courses)

Quantitative Methods Electives in HRMP

MPR310	Quantitative Methods for Personnel Management
MPR314	Quantitative Methods and Techniques for Public Manpower Planning & Evaluation

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Based on requirements detailed in Master's Degree Programs in Professional Studies 1979-80 and 1980-81. Published by Graduate School of Management and Urban Professions.

COURSE OFFERINGS

The courses offered to students in career entry programs of the Graduate School of Management and Urban Professions

Laboratory Courses
Methods Courses
Management Courses
Research Seminar
Professional Area Courses

Accordingly, courses are listed under the above five headings.

LABORTORY COURSES

Students in all career entry programs take the same laboratory courses. Differentiation for program purposes is accomplished through appropriate client selection. The laboratory sequence provides students with the opportunity to analyze problems of increasing complexity and breadth as they proceed through the program.

LAB 101 - Laboratory in Issue Analysis. This is the first in the sequence of three labs. It focuses on a single policy question that has reached the public or agency agenda and introduces students to the specific qualitative and quantitative techniques that can be applied to a range of problems. Students work as a team and undertake their analysis for a particular client drawn from the public, private or non-profit sector. The student teams undertake research and analysis of data, present alternatives, and make their recommendations to the clients who are typically under the pressure of limited time and information. The students learn how to function within a complec political environment in which the policymaking process is subjected to pressures by advocates of various positions, by the relevant bureaucracies and by different interest groups.

Team members quickly learn to grasp the environment of the problem and agency, to apply shortcut analytic techniques, and to use standard but often inadequate data sources and crude approximations. They make their findings known to the client in a formal briefing and through a technical paper. Skills in quantitative techniques and in verbal and graphic communication are stressed. Each team typically handles three problems during the semester.

Problems under study vary from year to year. Recent problems have included New York City development of hydro-electric generating capacity at its reservoirs; organizational arrangement for the delivery of ambulatory care services; renewal of J51 Tax Abatement Program by the Housing Development Administration in New York City; plan for the disposal of solid waste in Essex County, New Jersey, a mental health outreach program for the elderly in Clifton, New Jersey; promotional efforts for the New York City component of the "I Love New York" campaign.

LAB 102 - Laboratory in Program Assessment and Design. This lab deals with the set of policy decisions associated with the direction and operation of a specific program or program delivery system. Students work on two problems in a semester. The first problem involves an analysis of an existing program. It focuses on the development of criteria and methods for evaluating the effectiveness of the program, and for the development of recommendations for improvement. The second problem is concerned with program design. The student must think through the conception and implementation of a new program to deal with an unresolved problem, often an outgrowth of the issue studied during the first part of the lab. Students learn to translate promising concepts into detailed, workable proposals and to consider both the intended and unintended consequences of a given program or delivery system.

Students have recently worked on evaluation and design problems involving needs of the elderly in single-room occupancy dwellings; youth employment and demonstration projects program in Newark and Essex County, New Jersey; program design to aid tourists in emergency situations; impact of housing service programs for welfare recipients in New York City; the referral system between neighborhood health centers and the back-up hospitals in New York City.

LAB 103 - Laboratory in Resource Allocation. The work of this lab addresses the difficult process of allocating among and across programs and delivery systems. The allocation of resources is today one of the most pressing and vexing tasks of managerial and political leadership. In most allocation processes choices are all too often made without sufficient planning and analysis, and priorities are often implicit rather than explicit. The political and organizational environment creates stresses which may cut across systematic analysis, and the the student needs to learn how to assess that factor while at the same time applying an analysis to fiscal and non-fiscal resources, characteristics of capital and operating investments and understanding budget theory and practice. Students are asked to develop an analytic basis for supporting difficult choices among competing programs, neighborhoods, and groups of people within a realistic budgeting environment--fragmented, incremental, and decentralized.

As with the previous labs, students work in teams, taking various aspects of a larger problem or dealing with separate problems.

METHODS COURSES

These courses must be taken in tandem with the coresponding laboratory, as they are designed to become progressively more difficult.

MET 201 - Statistical Methods. This course introduces students to a variety of statistical methods and techniques relevant to the analysis of public policy issues. The purpose of this course is to (1) prepare students to read and analyze reports that include statistical information, and (2) prepare students to process data within an experimental framework. The two major subdivisions of the course material are descriptive and inferential statistics. Probability theory will be covered where necessary to support inferential statistical techniques.

MET 202 - Analytic Methods for Decision Making. This course introduces students to a wide range of analytic methods and techniques relevant to decision making. Some of the major areas in this course include management science, quantitative economics, and social science research design. Techniques are described with their advantages and shortcomings and are illustrated with examples.

MET 203 - Advanced Statistics. This course is an advanced level and is intended for students who have taken MET 201 and MET 202. Statistical methods such as multiple regression, partial correlation and analysis of variance will be covered. In addition, the student will be exposed to the statistical capabilities of Statistical Package for the Social Sciences (SPSS) and its applicability to the computer.

MANAGEMENT COURSES

The generic management courses are listed in this section. Management courses specifically related to professional areas listed under the appropriate area and are designated accordingly.

MGT 214 - Economic Principles for Managers and Policy Analysis. Designed to illustrate the major tools and concepts of micro-economic analysis and their application to decision making and policy formulation. Covers statistical and financial aspects of utilizing economic data in decision making. Special consideration will be given to cost benefit analysis (return on investment theory). Emphasis is on problem solving and case work.

MGT 215 - Introduction to Accounting for Management in the Private, Nonprofit and Public Sectors. The course is intended for those students who have had no formal instruction in the filed of accounting. It is an introductory course in accounting principles and practices designed to provide the management student with an essential body of knowledge applicable to all organizational settings. The course is intended to provide managers with an understanding of financial statements whether they are to be prepared for profit or not-for-profit entities. The accrual basis of accounting and the principles of income determination for profit oriented companies are covered. Also, an introduction to fund accounting for not-for-profit organizations and its basic principles is provided for the student.

MGT 401 - Organizational Behavior and Small Group Theory. Designed to give the student (1) an appreciation of organizational behavior and its gradual emergence as a field of practice and research; (2) some understanding of the major theoretical and methodological approaches to the study of organizational behavior. Organizational problems are studied, with special emphasis on the small group within the complex organization.

MGT 402 - The Practice of Management. Basic managerial concepts and techniques are stressed considering traditional and emerging organization structures. Development of awareness and/or skills in management processes is emphasized with particular attention to the specific professional environment. Includes goal definition, leadership, design planning, management accountability and capstone field/project application assignment.

MGT 403 - Management Uses of Accounting and Budget Information. This course is intended for the nonfinancial person and as such will cover the basic terminology, concepts and practices of accounting and budgeting. The student will be afforded ample opportunity to analyze, interpret and evaluate financial and budgeting statements. The behavioral aspects of accounting and budgeting information will also be discussed. Upon completion of the course the student should be conversant in the general aspects of accounting and should know what financial reports to require and how best to use them in light of organizational goals. (Prerequisite - MGT 215 or equivalent)

MGT 404 - Management Uses of Computers. Collecting, checking, selecting, organizing, and displaying data, Examination of capabilities and limitations of computer-based management information systems. Development of familiarity with computer capability for use in program specialization and in relating to computer professionals. Role of computer management information systems in uniformity and consolidation of decision

making. Step-by-step procedures in construction and implementation of feasibility studies, game theory, scheduling, simulation, and analytic models.

MGT 405 - Personnel Management. Examines the concepts underlying the personnel function, and reviews personnel administration from the point of view of both the personnel specialist and the line manager, includes consideration of such areas as recruitment and selection, training, career development, conpensation, collective bargaining and affirmative action. (Prerequisite - MPR 301)

MGT 406 - Managerial Communication. Designed for students who wish to improve such essential management skills as oral and visual communications, written reports, letters and memoranda, and the techniques of running a successful meeting.

MGT 410 - Planning and Control Systems. This course will explore alternative concepts of strategic and tactical planning, management and operational control. The course will focus on an evaluation of current formal planning and control systems in use in the public and private sector. Both technical and behavioral problems in the implementation of formal planning and control systems will be reviewed. Special attention will be paid to program budgeting and Management by Objective (MBO).

MGT 412 - Small Business Management. Covers basic approaches to planning a small business venture, with emphasis on sales and services offered, location and site selection, leasing, market availability, analysis of competition, sales strategies, business financing, organization, profit and loss, developing management and sales skills, understanding municipal regulations.

RES 600 - Research Seminar. Structured setting in which students develop topics for research and analysis, work plans, strategies for presentation of findings, and a finished professional paper required for the Master's degree. Class discussion and required intermediate tasks permit students to solve common problems and to proceed with their work in an efficient and logical manner. Considerable attention will be devoted to the relationship between substantive statements and the stylisic constraints of a monograph.

HUMAN RESOURCES AND MANPOWER DEVELOPMENT

MPR 301 - Introduction to the Field of Human Resources and Manpower Development. An introductory course which considers and analyzes manpower policies and programs in both the public and private sectors and focuses on the major institutions in the development of public policies affection employment, skill

acquisition, income maintenance and equal opportunity. Special emphasis is given to the effect of the War on Poverty and the Comprehensive Employment and Training Act. The private section of the course identifies major human resource policies and programs and provides an overview of the principal functional areas of human resources management.

MPR 302 - Labor Markets and the U.S. Economy. This course deals with the obstacles to optimal utilization of human resources in the U.S. economy at both the national and urban levels. At the national level problems of structural unemployment, income distribution, and the relationship between leisure and work as they affect the work force will be considered. A second part of the course will deal with variations in unemployment, income levels, and employment growth among urban areas and the causes of these differences. Special attention will be given to the New York Metropolitan area labor market. (Prerequisite-completion of Economics requirement).

MPR 303 - Sociology of Work. An analysis of work as an institution--its social functions and its meaning to individuals and families, including the economic, political and sociological implications of changing attitudes toward work. The economics, politics, and sociology of poverty are considered.

MPR 304 - Program Management in Public Manpower. This course addresses itself to the management of public manpower programs. Emphasis is placed on the practical problems commonly encountered in planning, designing, drafting, controlling and evaluating public manpower programs, as funded under the Comprehensive Employment and Training Act and other appropriate enabling legislation. The student will be introduced to a wide range of current management concepts and practices as they relate to the field of public manpower, e.g., Management-by-Objectives Zero-Based Budgeting, Matrix Organization. (Prerequisite-MPR 301)

MPR 305 - Techniques of Counseling. Provides an introduction to the theories and practices of individual and group counseling with special emphasis on the counselor's tool as applied in career development and at the work place. Comprehensive counseling for the worker will include factors indirectly related to the job and the needs of special employee groups.

MPR 306 - Urban Economic Development. Considers the economic future of central cities and suburban areas in the metropolitan region. The role of manpower factors in strengthening the economy of the metropolitan region is explored. New policy directions in housing, taxes, transportation, and education are explored with special emphasis on training the work force.

The extent to which business firms exercise civic and social responsibility in their urban centers is reviewed. (Prerequisite-MPR 302)

MPR 307 - Current Theories and Methods for Solving Performance Problems--A Management-Supervisory Function. Studies several techniques and models available to the supervisor in individual and organization performance, analyzing causes of those problems and identifying appropriate actions, and decisions. Considers a versatile strategy for developing the organization, analyzing the work process and designing and enriching work. Methods will be applied to a significant problem in the student's day-to-day work.

MPR 308 - Management Counsulting. The practice of management consulting in industry, government and the nonprofit area. Covers problem definition, goal setting, project planning and program management related to policy making, organization, systems development, and troubleshooting. How to use consultants; how to build a consulting career; new opportunities in the field for women; consulting in personnel administration. An orientation course that uses the case method. Student task forces investigate real cases in the classroom.

MPR 309 - Wage and Salary Administration. Focuses on aspects essential to meeting a basic goal: payment of employees equitably in a cost-efficient manner. Topics include the value of the job to the organization, employee proficiency, meeting labor market competition, and satisfying governmental requirements.

MPR 310 - Quantitative Methods for Personnel Management. Exposes students to predictive approaches used to solve personnel management problems and prepares them to request or to critically evaluate technical assistance in these areas. The course includes analysis of models appropriate to the field, such as linear programming, as well as simulation techniques. (Prerequisite-completion of Statistics requirement)

MPR 311 Manpower Issues in Health Services. For the professional practitioner with responsibility in manpower planning and personnel management in the field of health services. Considers such areas as organizational patterns, recruitment, training, motivation, and the employee-collective bargaining relationships unique to the health services field.

MPR 312 - Manpower Services for Special Groups. Explores manpower programs and services designed for special target groups, such as the Vietnam-era veteran, ex-offenders, the older worker, and the handicapped. Enabling legislation will be covered; CETA, Wagner-Peyser, Vocational Rehabilitation,

Social Security Act, Older Americans Act, etc. (Prerequisite-MPR 301)

MPR 313 - Training Programs Within Organizations. Intended for the nonprofessional trainer who will benefit from a better understanding of personnel training and development in business and finance. Topics include program development processes, identification of training needs, facilities, staffing, evaluation of program effectiveness, and controlling training costs. Students will use these basic elements in the design of a program.

MPR 314 - Quantitative Methods and Techniques for Public Manpower Planning and Evaluation. Analysis of employer and client needs and fund allocation for training and employment programs; cost benefit analysis as a projective planning tool and the theory and practice of evaluation research as applied to manpower programs, including the statistical methods involved. Practical experience is gained by the student in designing, conducting, and analyzing data from a small-scale research project. (Prerequisite-completion of Statistics requirement)

MPR 315 - Ethnicity and the Work Force. Concerned with the special problems unique to different ethnic groups in the metropolitan region, especially those problems affecting the work force. Particular attention is given to blacks, Hispanics and Asian-Americans, with emphasis on the training and employment problems of each group. Procedures for dealing with these are reviewed. (Prerequisite-MPR 302)

MPR 317 - Manpower Issues in Multinational Firms. Examines the multinational firm as an open system operating in a complex international environment. The purpose of the course is to develop a better understanding of this environment and its effects on the interactions among structural patterns, administrative policies and practices, decision-making modes, and the special problems faced in the management and utilization of human resources in multinational firms.

MPR 320 - Developing Programs in Retirement Planning. For human resources personnel who have the responsibility for developing retirement policy and programs in the private, public or nonprofit sectors. Special attention will be given to legislative and judicial aspects of mandatory retirement; individual and group counseling; incentives for voluntary retirement; performance appraisal for nonvoluntary retirement; career options for older adults; health, housing and legal problems; continuing education and a "life span" approach to work and leisure.

Available programs and materials will be critically examined with a view to creating new programs and materials to meet the specific needs of each member of the class.

MPR 370 - Regulatory Agency Impact on Personnel Management and Manpower Development. Considers in detail the implications of the Equal Employment Opportunity and Occupational Safety Acts for personnel management and the development of manpower plans in both the private and public sectors. Procedures in response to affirmative action programs and the compliance standards of federal agencies are reviewed. Special emphasis is given to the current and potential role of women in the labor force.

MPR 371 - Trade Union Movement and Collective Bargaining. Examines the institutional and economic aspects of the employer-employee relationship, including a review of the American labor movement, its development, organization and structure. The framework within which employers and employees prepare to function in the negotiating or collective bargaining process is stressed.

MPR 372 - The Legal Framework of Labor Relations. Reviews the laws, court decisions, and labor board rulings governing labor relations and collective bargaining, including the Labor Management Relations Act and the Taylor Law. Designed for management, labor people, and others interested in the subject of management-labor relations generally. Current developments in the legal framework are stressed.

MPR 373 - Issues in the Collective Bargaining Process. Stresses management and union approaches to labor negotiations and the bargaining techniques designed to best protect their respective interest. The issues include challenges to management prerogatives, labor objectives, union participation in the decision-making process, coverage of supervisory and management personnel under union contracts, nonmandatory bargaining issues, management and union counterpropsals, and new trends in collective bargaining.

MPR 374 - Seminar on Techniques in Labor-Management Dispute Settlement. Deals with the methods by which labor disputes are settled through grievance machinery mediation, fact-finding, and arbitration, including a detailed study of typical cases involved in day-to-day handling of labor problems, such as determination of arbitrability, reasons for discharge and discipline, seniority vs. ability in promotions, workloads and work assignments.

MPR 375 - Employee Benefit Plans. Explores the philosophy and identifies the principles underlying legally required and voluntary employer-sponsored benefit programs designed to cushion financial and other problems resulting from unemployment, disability, retirement, or death. Examines the details of coverage and financial accounting for group life, accident, disability, and medical insurance and pension plans in the United States; requirements for tax-exempt pension plans; self-insurance; stock ownership; and nonqualified deferred compensation plans.

Appendix Four

QUALIFICATIONS DESIRABLE FOR ALL PUBLIC MANAGERS

From

National Association of Schools of Public Affairs and Administration

GUIDELINES AND STANDARDS FOR PROFESSIONAL MASTERS DEGREE PROGRAMS IN PUBLIC AFFAIRS AND PUBLIC ADMINISTRATION

Prepared By

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For Discussions Regarding

THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION

LEADERSHIP DEVELOPMENT PROGRAMS

(A 1980 Advanced Study Center Project)

(October 1980)

QUALIFICATIONS DESIRABLE FOR ALL PUBLIC MANAGERS

(Five Subject Matter Domains)

POLITICAL-SOCIAL-ECONOMIC CONTEXT

1. Knowledge of:
   a. Cultural and social mores and patterns.
   b. Political values and processes.
   c. Governmental institutions, powers and relationships.
   d. Economic systems, incentives and controls.
   e. Environmental factors and resource availabilities.

2. Skills in:
   a. Analysis and interpretation of political-social-economic forces and trends.
   b. Application of political-social-economic knowledge to solution of public problems.
   c. Evaluation of the political-social-economic impact and consequences of administrative policies and actions.

3. Public Interest Values represented by knowledge of and commitment to:
   a. Democratic traditions and practices, constitutionalism and the rule of law.
   b. The purposes and limitations of government as an instrument for fostering social and economic progress.
   c. Access for individuals and groups to centers of power and decision making.
   d. The political direction and responsibility of administration and administrators.
   e. Standards of official/personal conduct and ethics.

4. Behavior represented by:
   a. Tolerance of diverse views of other persons and groups.
   b. Capacity to adjust to complex political-social environments and situations.
   c. Ability to function as a social/organizational change agent.
   d. Participation in public action programs, e.g., community development projects, citizen advisory groups, etc.

ANALYTICAL TOOLS: QUANTITATIVE AND NON-QUANTITATIVE

1. Knowledge of:

   a. Quantitative decision methodology: e.g., accounting, parametric and non-parametric statistics, linear programming, modeling, etc.
   b. Electronic data processing and information systems.
   c. Systems and procedures analysis; e.g., organization surveys, work measurement, etc.
   d. Behavioral science methodology; e.g., sociometric surveys, value analysis, leadership assessment, etc.
   e. Legal processes and controls.

2. Skills in:

   a. Logical analysis and diagnosis.
   b. Research design and application.
   c. Computer utilization and application.
   d. Application of quantitative and non-quantitative methodology to organizational situations.
   e. Oral and written communications and presentations.

3. Public Interest Values represented by knowledge of and commitment to:

   a. Objectivity and rationality in the conduct of public affairs.
   b. Utilization of science and research to foster public purposes
   c. Impartial inquiry and investigation of public needs and problems.
   d. Openness in communication and interpretation of data and findings to the public.

4. Behavior represented by:

   a. Involvement in data gathering and problem solving exercises.
   b. Familiarity with public documents, legal sources and forms of administrative communications.
   c. Preparation of correspondence, reports and position papers.
   d. Participation in professional associations, internships and other forms of experiential learning.

INDIVIDUAL/GROUP/ORGANIZATIONAL DYNAMICS

1. Knowledge of:
   a. Individual and group behavior; e.g., individual motivation, dynamics of groups, modes of leadership, etc.
   b. Organization structure, process and dynamics; e.g., models, authority, development strategies, decision making, etc.
   c. Communications theory and process.
   d. Professionalism and public service; e.g., evolution of public services, roles and standards of professions, characteristics of bureaucracies, etc.

2. Skills in:
   a. Personal motivation and leadership.
   b. Interpersonal and group relationships.
   c. Identification and analysis of political and organizational power.
   d. Application of appropriate models of organization, leadership and decision making.
   e Coping with organizational stresses, limitations and change.

3. Public Interest Values represented by knowledge of and commitment to:
   a. Protection and fostering of individual rights, liberties and welfare.
   b. Promotion of organizational equity and effectiveness.
   c. Reconciliation of private interests with public objectives and needs.
   d. Concern for the clients served by the organization.

4. Behavior as represented by:
   a. Consistency, genuiness and integrity in human and organizational relationships.
   b. Positive attitudes concerning individual growth and organizational improvement.
   c. Willingness to share insights and experiences with others.
   d. Recognition and understanding of variations in human and organizational motivations and approaches.
   e. Participation in professional associations, internships and other forms of experiential learning.

POLICY ANALYSIS

1. Knowledge of:
   a. Application of analytical and administrative tools to solution of public problems.
   b. Processes by which policy is formulated, implemented, and evaluated.
   c. Strategies for optimization and selection of alternatives.
   d. Distinctive attributes of policy relative to specific functional areas; e.g., health, transportation, etc.

2. Skills in:
   a. Socio-economic analysis; e.g., cost-benefit analysis, social impact analysis, etc.
   b. Political diagnosis; e.g., public opinion evaluation, group power surveys, legislative-executive relationships, etc.
   c. Problem comprehension and interpretation; e.g., identification of strategic issues, liaison skills, advocacy, etc.
   d. Policy measurement, scaling and design.
   e. Program impact measurement; e.g., program evaluation, outcome or effectiveness measurement, etc.

3. Public Interest Values represented by knowledge of and commitment to:
   a. The use of data and analysis to enlarge the scope of public choice.
   b. Policies and programs which foster equality of opportunity and well-being.
   c. Measures to increase citizen understanding of public policies and their impact.
   d. Standards of program formulation and conduct.
   e. Procedures for full and fair assessment of program benefits and costs to various publics.
   f. Measures to increase client and public participation in public policy formulation and evaluation.

4. Behavior represented by:

   a. Ability to relate and integrate diverse factors to common objectives.
   b. Methods of adaptation to political and organizational pressures and constraints.
   c. Ability to bargain, compromise and arbitrate.
   d. Participation in professional associations, internships and other forms of experiential learning.

ADMINISTRATIVE/MANAGEMENT PROCESSES

1. Knowledge of:

   a. Administrative planning and organizational design.
   b. Management systems and processes including leadership, decision making, direction, and organization development and change.
   c. Personnel administration including staffing, training and collective bargaining.
   d. Finance and budgeting.
   e. Program evaluation and control.

2. Skills in:

   a. Conceptualizing, goal setting, organization design and program development.
   b. Work assignment and supervision.
   c. Negotiating and persuading.
   d. Monitoring, assessment and review.

3. Public Interest Values represented by knowledge of and commitment to:

   a. The role and use of organizations and administrative processes to achieve public objectives.
   b. Standards of efficiency and effectiveness in the conduct of the public's business.
   c. Standards of individual and organizational integrity and performance.
   d. Public surveillance and review by citizens and their elected representatives.
   e. A working environment conducive to individual fulfillment and the attainment of public confidence.

4. Behavior represented by:

   a. Openness to new ideas and proposals.
   b. Recognition and consideration of strengths, weaknesses and desires of others.
   c. Facility in applying management tools and processes to varied organizational situations and problems.
   d. Effectiveness in undertaking organization and management surveys.
   e. Participation in professional associations, internships and other forms of experiential learning.

Appendix Five

SAMPLE M.Ed. IN EDUCATIONAL TECHNOLOGY

Based on Information Provided in

THE 1979-80 TEXAS A&M UNIVERSITY GRADUATE CATALOG

and

MASTER OF EDUCATION IN EDUCATIONAL TECHNOLOGY:
Combining Modern Tools and Techniques
To Produce Better Educational Communications

Prepared By

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(Tel. #800-848-4815)

For Discussions Regarding
THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION
LEADERSHIP DEVELOPMENT PROGRAMS
(A 1980 Advanced Study Center Project)

(December 1980)

DEPARTMENT OF INDUSTRIAL EDUCATION
TEXAS A&M UNIVERSITY
(Institutional Statements)

The Department of Industrial Education offers graduate programs leading to Master of Education, Master of Science, Doctor of Education, and Doctor of Philosophy degrees. Areas of specialization in industrial arts, vocational industrial education, educational technology, technical education, and traffic safety education are available within each degree program. A student may earn the professional teaching certificate in industrial arts for the State of Texas by completing course requirements through this Department.

Graduate courses in industrial education are intended to provide the student the opportunity to develop the skills and knowledge generally required of industrial educators, researchers, program directors, and departmental administrators. Specific information concerning the requirements for each of the degrees and procedures for meeting those requirements is available from the Department upon request.

The Department participates in interdisciplinary planning, research and evaluation programs offered in cooperation with other departments in the College of Education. Prospective doctoral students who wish to develop an interdisciplinary supporting field in educational planning, research and evaluation should examine the interdisciplinary studies option which is presented in the description of graduate courses in interdisciplinary education. Within the framework of existing doctoral programs of the departments in the College of Education, individuals may pursue an area of emphasis in higher education.

EDUCATIONAL TECHNOLOGY

Educational Technology is more than machines adapted to the instructional process. It is a systematic way of thinking concerned with designing, developing, disseminating, utilizing,

and evaluating the learning-teaching process in terms of specific educational objectives. Like most graduate programs, Educational Technology has no semester-by-semester curriculum. The degree consists of 36 semester hours of course work selected on the basis of the student's previous experiences and future objectives. At least 18 semester hours (but not more than 24 semester hours) of course work must be in Educational Technology. The remainder of the program may be in one or more supporting areas such as Curriculum and Instruction or Educational Psychology. Educational Technology may also be used as a supporting area (minor) for doctorates in other fields.

Financial assistance is available for graduate assistants, teaching assistants and instructors in some areas of Educational Technology (audio-visual communication, electronics, graphic communications).

M. Ed. in EDUCATIONAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL EDUCATION
TEXAS A&M UNIVERSITY

Sample Course with Emphasis on Information Sciences

Educational Technology (Core Courses)

- EDTC613 Utilization of Instructional Material
- EDTC615 Selection and Evaluation of Learning Resources
- EDTC621 Graphic Communication
- EDTC631 Instructional Television
- EDTC641 Message Design
- EDTC651 Computer Assisted Instruction
- EDTC684 Professional Internship

Educational Curriculum & Instruction (Electives)

- EDCI673 Analysis of Teacher Behavior
- EDCI675 Teaching Strategies: Patterns of Learning

Educational Psychology (Electives)

- EPSY622 Measurement and Evaluation in Education
- EPSY625 Test Construction
- EPSY636 Techniques of Research

Computer Science (Electives)

- CS602 Information Processing Languages
- CS603 Assembly Language
- CS613 Computer Software Systems
- CS622 Computer Communications and Networks

Based on requirements detailed in Master of Education in Educational Technology: Combining Modern Tools and Techniques to Produce Better Educational Communications, College of Education, Texas A&M University.

EDUCATIONAL TECHNOLOGY

EDTC 613 - Utilization of Instruction Materials. Study of communications with emphasis upon senses of hearing and seeing in teaching-learning processes. Laboratory experiences in the selection, preparation, utilization and evaluation of instructional materials.

EDTC 615 - Selection and Evaluation of Learning Resources. Selection of book and non-book learning resource materials for specific needs or for general collections. Utilization of basic sources of information on commercially prepared materials with emphasis in the student's area of specialization.

EDTC 621 - Graphic Communication. Application of research findings and design criteria to graphic communication design techniques. Emphasis given to techniques of preparation and utilization of programmed slide sets, filmstrips, and motion pictures and their application in instructional systems.

EDTC 631 - Instructional Television. Utilization of television in instructional systems. Program design and content specification.

EDTC 641 - Message Design. Systematic application of task and learner analysis research findings and design criteria to the design of instructional materials.

EDTC 651 - Computer Assisted Instruction. Design of computer delivered instruction. Basic applications of task analysis, learning theory, and programming principles to frame construction and sequencing. Relevant computer languages. Preparation of linear and nonlinear CAI programs.

EDTC 684 - Professional Internship. Supervised experiences in performing professional functions appropriate to career goals.

EDUCATIONAL CURRICULUM AND INSTRUCTION

EDCI 673 - Analysis of Teaching Behavior. Methods of gathering teaching behavior data. Use of computer for analyzing and interpreting data collected. Video-type recording micro-teaching lessons.

EDCI 675 - Teaching Strategies: Patterns of Learning. Learning and teaching theory and research applied to development of teaching strategies appropriate for various contents, objectives,

and instructional situations. Variables influencing learner behavior and approaches to optimization of teacher behavior.

EDUCATIONAL PSYCHOLOGY

EPSY 622 - Measurement and Evaluation in Education. Principles of psychological testing applied to education. Uses and critical evaluation of achievement and aptitude, interest, and personality tests and performance in education settings.

EPSY 625 - Test Construction. Planning, construction, analysis, and evaluation of written and performance tests. Test item analysis, reliability studies, and validity studies. Development of test norms, score transformations, and equivalent forms of tests. Prequisite: EPSY 622.

EPSY 636 - Techniques of Research. Fundamental concepts and tools of research applied to psychological and educational problems. Rationale of research, analysis of problems, library skills, sampling, appraisal instruments, statistical description and inference, writing the research report, and representative research designs.

COMPUTING SCIENCE

CS 602 - Information Processing Languages. Application of computers to information processing problems. Programming of data processing problems in COBOL. Sorting, searching, decision tables, random access devices, and systems analysis. Note: This course may not be taken for graduate credit by computing science majors.

CS 603 - Assembly Language. Computer architecture and system software through the assembly languages of a minicomputer and a large scale computer. Machine structure; assembly language; machine language; addressing techniques; and digital representation of data. Subroutine linkage; reentrant code, and macros. Assembly language programming assignments. Prerequisite: Knowledge of some programming language. Note: This course may not be taken for graduate credit by computing science majors.

CS 613 - Computer Software Systems. Hardware/software evolution leading to 3rd generation operating systems. Operating system concepts and system elements as separate entities followed by synthesized examples from the areas of minicomputer and large scale computer applications. Comparison of major manufacturer's current operating systems. Prerequisite: CS 603.

CS 622 - Computer Communications and Networks. Basic hardware/software for computer communications. Synchronous/asynchronous systems. Computer networks routing, protocols. Time sharing systems, interface between operating system and network. Common carrier services. Prerequisites: CS 613.

Appendix Six

I.C.P.S.R. COURSE DESCRIPTIONS AND TIME SCHEDULE

Based on Information Provided in

INTER-UNIVERSITY CONSORTIUM FOR
POLITICAL AND SOCIAL RESEARCH
1980 TRAINING PROGRAM
IN THE THEORY AND TECHNOLOGY OF SOCIAL RESEARCH

Prepared by

James F. McNamara
Advanced Study Center
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210
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For Discussions Regarding
THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION
LEADERSHIP DEVELOPMENT PROGRAMS
(A 1980 Advanced Study Center Project)

(December 1980)

FIRST TERM TIME SCHEDULE

June 30-July 25

Time	Lectures
9 a.m. — 10 a.m.	Elementary Mathematics for Social Scientists Mathematics for Social Scientists
10 a.m. — 11 a.m.	Dynamic Analysis Formal Theories of Social Research
11 a.m. — 12 p.m.	Evaluation Research Methodology
1 p.m. — 2:15 p.m.	Introduction to Computing (July 1-July 3) Topics in Computing (July 7-July 9) Topics in Computing (July 14-July 16)
	Lecture/workshops
10 a.m. — 12 p.m.	Quantitative Historical Analysis II Empirical Research Issues in Aging Quantitative Analysis of Mass Communication
2:30 p.m. — 4:30 p.m.	Introduction to Statistics and Data Analysis I Introduction to Linear Models Intermediate Linear Models Advanced Linear Models Applied Multivariate Analysis Archiving Criminal Justice Data (June 30-July 11)

SECOND TERM TIME SCHEDULE

July 28-August 22

Time	Lectures
9 a.m. — 10 a.m.	Data Analysis and Public Policy
1 p.m. — 2:15 p.m.	Critiques of Social Research (August 4-August 15) Dynamic Models of Political Economy Introduction to Computing (July 28-July 30) Topics in Computing (August 4-August 6) Introduction to SPSS (August 18-August 20)
	Lecture/workshops
9 a.m. — 5 p.m.	Asian American Research Methods (July 28-August 8) Database Management for Complex Data Sets (July 28-August 1) Quantitative Analysis of Crime and Criminal Justice
10 a.m. — 12 p.m.	Advanced Linear Models Causal Models Experimental Studies of Social Phenomena Exploratory Data Analysis Models with Unmeasured Variables Multivariate Dimensional Analysis
2:30 p.m. — 4:30 p.m.	Applied Nonparametric Statistics (July 28-August 8) Discrete Multivariate Analysis Intermediate Linear Models Introduction to Statistics and Data Analysis II Multi-level Analysis (August 11-August 22) Time Series Analysis

COURSE DESCRIPTIONS

TRACK I

Elementary Mathematics for Social Scientists (Lecture: no credit) There are no formal prerequisites for this course. This four-week series of lectures is designed to introduce the student to those basic mathematical skills that are necessary for a meaningful understanding of elementary statistics, data analysis, and social methodology. Course content includes a discussion of mathematical notation, basic set theory, various number systems, the algebra of numbers, the notion of a function, the study of several important classes of functions, and solutions to systems of linear equations. In addition, several approaches to the specification of probability will be examined, and some basic statistical concepts will be introduced. The general discourse will be at about the level of W.L. Bashaw's *Mathematics for Statistics*.

Introduction to Computing (Workshop: no credit) There are no prerequisites for this course. The purpose of this four-day workshop is to introduce participants to the computing resources of the University of Michigan. The instructional format will include both lectures, focusing on the practical aspects of computing on the Michigan Terminal System (MTS), and guided exercises, designed to provide the novice with some degree of competence (and confidence) in computing. Of primary importance will be provision of information of immediate relevance for computing assignments in the Training Program's workshops and lecture/workshops. Additional topics include a comparative introduction to the statistical, data analytic, and graphics software most useful to participants interested in quantitative analysis of social phenomena.

Introduction to Statistics and Data Analysis I (Lecture/workshop: 3 credits) There are no formal prerequisites for this course; however, participants who have weak mathematical backgrounds, are well advised to audit **Elementary Mathematics for Social Scientists**. The instructional format for this four-week course will be some combination of a lecture and an intensive practicum in which some of the basic principles of statistical analysis will be examined. Topics will include the logic and purpose of experimental and statistical control in data analysis; problems of measurement, scaling, and index construction; statistical reliability and validity; basic probability theory; descriptive statistics; random variables and their distributions; sample statistics; hypothesis testing and confidence intervals; basic statistical inference; and analysis of two-dimensional contingency tables. The flow of the investigator's activities between problem definition, theory development, selection and measurement of constructs and their indicators, data collection, and methods of analysis will be emphasized throughout. Wonnacott and Wonnacott's *Introductory Statistics for Business and Economics* (2nd edition) is one of numerous texts that is appropriate for this course.

TRACK II

Critiques of Social Research (Lecture: no credit) This two-week lecture series is devoted to a critical assessment of past and current utilization of mathematical and statistical methods in analysis of social phenomena. While not focusing on a direct critique of the methodology of social research, the lectures will include many examples of inappropriate, pseudo, shoddy, or trite analyses that may seem to the methodologically untrained scholar to be rather sophisticated research endeavors. The general character of the lectures may be sampled by reading Andreski's *Social Science as Sorcery* or Hutchison's *Knowledge and Ignorance in Economics*.

Data Analysis and Public Policy (Lecture: no credit) While there are no formal prerequisites for this course, it would be useful to have as background the ICPSR's **Introduction to Statistics and Data Analysis I** and **Evaluation Research Methodology**. This four-week series of lectures is designed to present participants with a conceptual, problematic approach to the formulation of policy decisions. Various analytic designs will be examined; however, instead of analyses which culminate in the standard mathematical or statistical decision, the designs will be formulated with the much broader policy decision in mind. By examining numerous concrete examples (e.g., energy models, air pollution and lung cancer models, judicial fairness models, health care models, scholastic performance models, demographic models) the complex relationship between the underlying problem, the analytic design, the available data or information, and the policy decision will be elucidated. Course content will also include a brief overview of the current state-of-the-art of evaluation research.

Dynamic Analysis (Lecture: no credit) **Elementary Mathematics for Social Scientists** and a solid introductory course in applied statistics are prerequisites for this course. This four-week series of lectures provides an introduction to and an overview of analytic treatments of longitudinal data, as well as an investigation of various problems that arise in the study of change. Course content includes a general discussion of time series, cohort, and panel analyses, with primary emphasis on the latter. The principal objectives of the lectures are to inspire an awareness of techniques designed to analyze change and to explore, in some depth, the potential and limitations of those techniques. The content of the first four chapters of Nelson's *Applied Time Series Analysis* and Glenn's *Cohort Analysis* provides some indication of the focus of this course.

Mathematics for Social Scientists (Lecture: no credit) An understanding of basic mathematical ideas at the level of the ICPSR's **Elementary Mathematics for Social Scientists** is a prerequisite for this course. This four-week series of lectures will focus on various mathematical topics, knowledge of which is essential for understanding most of the ICPSR Track II courses, in particular, the lecture/workshops devoted to linear modeling. Emphasis will be placed upon understanding the basic concepts of applied matrix algebra and development of an intuitive knowledge of differential and integral calculus. Several important classes of functions will be defined and their usefulness will be illustrated. Matrix algebra will be discussed at about the level of Campbell's *Linear Algebra With Applications (Including Linear Programming)*, and the first six chapters of Thomas' *Calculus and Analytic Geometry* (4th edition) capture the nature of the calculus discourse.

Applied Multivariate Analysis (Lecture/workshop: 3 credits) A solid introductory course in applied statistics at about the level of Hays' *Statistics for the Social Sciences* (2nd edition) and the ICPSR course **Mathematics for Social Scientists** are prerequisites for this course. The purpose of this four-week lecture/workshop is to introduce participants to some methods that are useful for analyzing multivariate data. Included among these methods are canonical correlation analysis, cluster analysis, discriminant analysis, factor analysis, multivariate analysis of variance (MANOVA), multiple regression, and principal components analysis. The content of Overall and Klett's *Applied Multivariate Analysis* includes most of the topics that will be examined in this course.

Applied Nonparametric Statistics (Lecture/workshop: 2 credits) The ICPSR's **Introduction to Statistics and Data Analysis I** or its equivalent is a prerequisite for this course. This two-week lecture/workshop is designed to provide the student with a repertoire of methodological techniques that are useful for analyzing the relationships between variables that are measured on nominal or ordinal scales. Specific topics include goodness-of-fit tests; inferences concerning location based on one sample, paired samples, or two or more samples; general distribution tests for two or more independent samples; association analysis; and tests for randomness. Gibbon's *Nonparametric Methods for Quantitative Analysis* includes most of the topics that will be discussed in this course.

Experimental Studies of Social Phenomena (Lecture/workshop: 3 credits) Participants who expect to take this course should have been exposed to the general notion of statistical experimental designs, say, at the level of that in Hays' *Statistics for the Social Sciences* (2nd edition) or Iverson and Norpoth's monograph, *Analysis of Variance*. This four-week lecture/workshop includes discussion of the logic of experimentation, research design and analysis of experimental data, special problems (e.g. obtrusiveness, repeated measures, validity, missing data), and evaluation of experiments as decision-making tools in policy analysis. The general philosophy of the course is that of "learning by doing," and several experiments will be designed and carried out as part of the instructional strategy. Much of the material covered in this lecture/workshop may be found in Reiken and Boruch's *Social Experimentation* or in Sidman's *Tactics of Scientific Research*.

Dynamic Models of Political Economy (Lecture: no credit) Students attending these lectures should have a command of the concepts of linear modeling at approximately the level of the Consortium's **Intermediate Linear Models**. The objective of this four-week lecture series is to merge various political and economic issues into a comprehensive theory, one that is useful for both predicting and explaining the interaction between aggregate economic conditions and public policy. Relevant topics of discussion will include objective function definitions of social welfare and welfare maximization strategies; the relationships between inflation, unemployment, and economic growth; models of electoral behavior, focusing on the extent to which economic conditions determine electoral outcomes; party difference vis-a-vis economic goals, policy instruments, and economic outcomes; political business cycles and the periodicity of elections; and long term trends in political business cycles. Tufte's *Political Control of the Economy* discusses many of the topics that will be examined in this course.

Evaluation Research Methodology (Lecture: no credit) While there are no prerequisites for this four-week lecture series, it would be helpful to have had a solid introductory course in applied statistics at the level of Wonnacott and Wonnacott's *Introductory Statistics for Business and Economics* (2nd edition). This course will focus on both the theoretical structure of evaluation research and many of the practical issues that are of special relevance to the research scholar who is designing and implementing an evaluation study. Topics of interest will include identification and measurement of objectives and processes, examination of measurement problems, experimental and quasi-experimental designs and evaluation in the absence of designs, and cost-utility analysis. Of particular interest will be the relationships between objectives, evaluation, and subsequent policy decisions. Rossi, Freeman, and Wright's *Evaluation: A Systematic Approach* includes many topics that will be introduced in these lectures.

Formal Theories of Social Research (Lecture: no credit) An introductory course on the order of **Elementary Mathematics for Social Scientists**, while not a prerequisite, would make this course much more meaningful. This four-week lecture series is designed to provide participants with knowledge of recent work in the areas of formal or mathematical approaches to theory development in the social sciences. Often organized under the rubric of positive economic, political, or social theory, the course content may include the study of individual preferences, the nature of participation, collective decision-making, constitutional choice, the theory of public and private goods, voting theories, coalition formation, models of interaction, specification of power, and models of "optimal" behavior. During any given summer term, this course may emphasize formal theories of economic, political, sociological, or other social science phenomena. Should emphasis be placed upon political theories, for example, Riker and Ordeshook's *An Introduction to Positive Political Theory* would be one of several appropriate texts.

Introduction to Linear Models (Lecture/workshop: 3 credits) Students taking this course should have had a solid grounding in applied statistics at approximately the level of Hays' *Statistics for the Social Sciences* (2nd edition) or Wonnacott and Wonnacott's *Introduction to Statistics for Business and Economics* (2nd edition). It is possible (although not optimal) to take this course in sequence with **Introduction to Statistics and Data Analysis I**. Relevant topics will include the mathematics of linear relationships, least squares and maximum likelihood estimation procedures, analysis of residuals, the general linear model, dummy variables, and a few of the typical problems associated with linear regression and correlation. Wonnacott and Wonnacott's *Econometrics* is one of many texts that are appropriate for use as the primary resource for this course.

Intermediate Linear Models (Lecture/workshop: 3 credits) The prerequisites for this lecture/workshop are an introductory course in applied statistics at the level of Hays' *Statistics for the Social Sciences* (2nd editon) and a background in elementary mathematics that is sufficient for the study of matrix algebra. The content of this course will include the nature of a linear model, least squares and maximum likelihood estimation, analysis of residuals, the general linear model, violation of assumptions (multicollinearity, heteroschedasticity, autocorrelation, measurement error, specification error), and models with dummy variables; and these concepts will be motivated by and illustrated with numerous substantive examples. Although knowledge of matrix arithmetic is not a prerequisite for this course, some concepts in matrix algebra will be introduced at such time as it seems desirable to study various topics in greater generality. Kmenta's *Elements of Econometrics* and Intrilogator's *Econometric Models, Techniques, and Applications* are two of a large number of texts that could be used for this course.

Introduction to Statistics and Data Analysis II (Lecture/workshop: 3 credits) This course is a continuation of **Introduction to Statistics and Data Analysis I**, and that course, or its equivalent, is a prerequisite for this one. Course content will include the notion of a linear model, the analysis of variance model, the linear regression model, least squares and maximum likelihood estimation procedures, measures of association, and analysis of covariance. Each statistical concept will be illustrated by numerous substantive examples drawn from social research. Wonnacott and Wonnacott's *Introductory Statistics for Business and Economics* (2nd edition) contains most of the information that will be discussed in this course.

Multi-level Analysis (Lecture/workshop: 2 credits) An applied statistics course at approximately the level of Wonnacott and Wonnacott's *Introduction to Statistics for Business and Economics* (2nd edition) is a prerequisite for taking this course. This two-week long lecture/workshop focuses on the classical problem of ecological inference; that is, the use of aggregate data to study individuals. Also covered are topics in group and contextual effects, estimation from grouped observations, methods of choosing appropriate units of analysis, specification of appropriate analytical models, and, time permitting, the extent to which multi-level analysis is useful in evaluation research. Hannan's text, *Aggregation and Disaggregation in Sociology*, includes much of the material that will be examined in this course.

TRACK III

Advanced Linear Models (Lecture/workshop: 3 credits) Students who elect to take this course must have had a solid introduction to linear modeling, *at least* at the level of the ICPSR's **Introduction to Linear Models**, and be capable of following mathematical derivations that are based upon calculus and matrix algebra. The Consortium's **Mathematics for Social Scientists** would provide, at best, the *minimal* background expected of students who take this course. Topics that will be studied include the general linear model, various estimation procedures for parameters of the model, violation of the assumptions underlying the model (multicollinearity, heteroschedasticity, autocorrelation, measurement error, specification error), special models (dichotomous dependent variables, dummy variables, nonlinear models), and an introduction to simultaneous equation models. Kmenta's *Elements of Econometrics* or Seber's *Linear Regression Analysis*, as well as many other texts, capture the general orientation of the course.

Causal Models (Lecture/workshop: 3 credits) Students may enroll in this course only if they have taken the lecture/workshop, **Intermediate Linear Models** and the lecture series, **Mathematics for Social Scientists** or their equivalents. This four-week course provides a rigorous introduction to parameter estimation in various types of both recursive and nonrecursive simultaneous equation (causal) models. Estimation criteria such as ordinary least squares, instrumental variables, generalized least squares, maximum likelihood, and two- and three-stage least squares will be discussed. In addition, analytic problems induced by model misspecification, overidentification, underidentification, and various violations of the assumptions of causal modeling will be examined. Time permitting, models with unmeasured variables will be introduced and multiple indicator models will be explored. The level of discourse is approximately that of Kmenta's *Elements of Econometrics*.

Discrete Multivariate Analysis (Lecture/workshop: 3 credits) Only participants who have taken **Intermediate Linear Models** and **Mathematics for Social Scientists** will be allowed to enroll in this course. This four-week course is designed to be an introduction to a variety of those topics that are organized under the rubrics of discrete multivariate analysis, multidimensional contingency table analysis, nominal data analysis, or qualitative data analysis. Primary attention will be focused on log-linear models; however, other approaches (minimum discrimination information, weighted least squares, logistic modeling) to analysis of data measured on nominal scales will be discussed. Course content includes maximum likelihood estimation in complete tables, model selection and goodness-of-fit, logit and probit analysis, causal analysis using log-linear models, alternative estimation procedures in complete tables, and, time permitting, examination of various measures of association. Fienberg's book, *The Analysis of Cross-Classified Categorical Data* and Reynold's text, *The Analysis of Cross-Classifications* contain almost all of the material that is relevant to this course.

Exploratory Data Analysis (Lecture/workshop: 3 credits) While there are no formal prerequisites for this course, it is likely to be much more meaningful for those students who have had a course in applied statistics at approximately the level of Hays' *Statistics for the Social Sciences* (2nd edition). This four-week lecture/workshop represents a departure from the study of classical (confirmatory) statistics or social methodology in the sense that the exploratory techniques are designed to probe for structure in data that may or may not have been obtained by random sampling within the context of a designed experiment. Course content includes box plots, stem-and-leaf displays, re-expression, median polish, smoothing, and robust regression. Interactive computing is essential to exploratory analysis so most data exploration will be conducted with the aid of a set of APL programs. The level of discourse will be essentially that of McNeil's *Interactive Data Analysis* or Hartwig and Dearing's *Exploratory Data Analysis*.

Models with Unmeasured Variables (Lecture/workshop: 3 credits) Students who enroll in this lecture/workshop should have taken the Consortium's **Intermediate Linear Models, Applied Multivariate Analysis, and Mathematics for Social Scientists** or their equivalents. The models discussed in this course are of two types, measurement models and structural equation models. Specific topics include classical test/measurement theory, constructs and their indicators, measurement error, the relationship between factor analysis techniques and generalized covariance analysis, and, Jöreskog's LISREL models. Much of the content of the course is covered in Jöreskog and Sörbom's monograph *Analysis of Linear Structural Relationships by the Method of Maximum Likelihood*.

Multivariate Dimensional Analysis (Lecture/workshop: 3 credits) Participants who elect this course should have had an introductory course in applied statistics at about the level of Hays' *Statistics for the Social Sciences* (2nd edition) and they should have a mathematical competency consistent with the content of the ICPSR course **Mathematics for Social Scientists**. This four-week lecture/workshop focuses on data analytic techniques designed to uncover the structure of multivariate phenomena. Course content includes an introduction to the unfolding model, factor analysis, Guttmann scaling, nonmetric multidimensional scaling, individual difference scaling, and cluster analysis. Relationships between exploratory data reduction, statistical model estimation, and analytic interpretation will be discussed in connection with methods of configuration comparison. Although there is no text which satisfactorily addresses all of these topics, Shepard, Romney, and Nerlov's two-volume work, *Multidimensional Scaling: Theory and Applications in the Behavioral Sciences* contains much relevant information.

Time Series Analysis (Lecture/workshop: 3 credits) Both ICPSR courses, **Intermediate Linear Models** and **Mathematics for Social Scientists** are prerequisites for this course. This four-week course focuses on several approaches to the analysis of time series data, including the classical decomposition of a time series into its constituent elements, analysis using the Box-Jenkins' ARIMA models and transfer functions, integration of the classical decomposition and Box-Jenkins' approaches with the econometrics tradition of time series analysis, and pooling cross-sectional data with time series data (to show the relationship between time series and panel analysis). Kendall's *Time Series* and Nelson's *Applied Time Series Analysis* include most of the material that will be covered in this course.

Data Processing and Data Management in the Criminal Justice Field (Workshop: no credit) Only individuals who have taken an applied statistics course at the level of Hays' *Statistics for the Social Sciences* (2nd edition) and who have "fairly extensive" computing skills will be admitted for participation in this course. This two-week workshop is designed to satisfy the needs of practitioners whose professional responsibilities include the provision of data management and data analytic services based upon computer-readable social science data files in the criminal justice arena. The course discussions will focus on ICPSR data resources obtained in cooperation with the Law Enforcement Assistance Administration (LEAA). This is a "data confrontation" workshop in which participants will be expected to articulate and examine problems relevant to their own specific research interests, analyze various data sets, and share data managements and data analysis experiences. Enrollment will be limited to twenty individuals who will receive stipend support under a program sponsored by the LEAA.

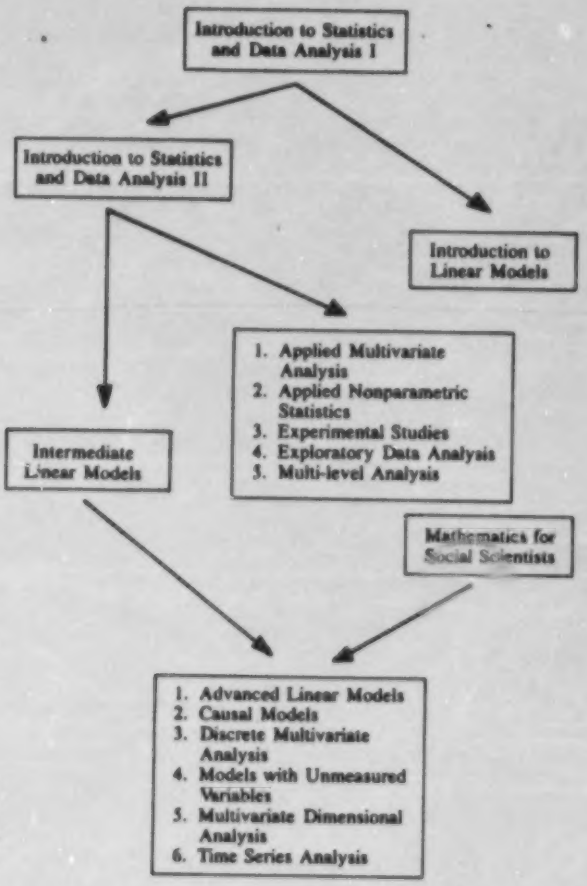
Empirical Research Issues in Aging (Seminar: no credit) An applied statistic course at approximately the level of Wonnacott and Wonnacott's *Introduction to Statistics for Business and Economics* (2nd edition) and at least a rudimentary knowledge of computing are prerequisites for this course. This four-week seminar will be devoted to discussion and analysis of various critical issues of the aging and the aged, including economic concerns, social policies, health programs, recreation, and, more generally, quality of life considerations. Participants will analyze data developed by the ICPSR in conjunction with a project supported by the Administration on Aging (AoA). Enrollment will be limited to forty students including twenty who will receive stipends under the sponsorship of the AoA. The remaining places are reserved for twenty minority group scholars who will receive stipend support from AoA to participate in the ICPSR's methodology courses.

Quantitative Analysis of Crime and Criminal Justice (Seminar: no credit) Participants who take this course should have already had or should be enrolled in **Introduction to Statistics and Data Analysis I and II** or its equivalent. In this four-week seminar, the primary issues of and approaches to the study of crime and the criminal justice system will be reviewed. Primary emphasis will be on important substantive problems of criminal justice — not on statistical methods — and much of the discussion will be based upon ICPSR data resources that have been developed in conjunction with the Law Enforcement Assistance Administration (LEAA). Data analysis using the computer is an integral part of the course. Enrollment will be limited to twenty students, and stipend support for those admitted for participation will be provided by the LEAA.

Quantitative Analysis of Mass Communication (Lecture/workshop: 3 credits) The **ICPSR's Introduction to Statistics and Data Analysis** is a prerequisite for this course. Participants who elect this four-week course will study problems associated with the collection and utilization of mass media audience data. Emphasis will be directed at conceptualizing research problems which address significant issues in communication theory, and much attention will be given to important related questions of public policy. A variety of topics, including the effects of the media on the attitudes and behavior of individuals and the utilization of the media to achieve political and societal objectives, will be examined. Students will analyze large data sets with content drawn from such diverse arenas as communication and political behavior, socialization, time budgeting, and the formation of life styles. Many of the topics germane to the course objectives are contained in McLeod and Chaffee's *The Social Influence Process*.

Quantitative Historical Analysis I (Lecture/workshop: 3 credits) There are no prerequisites for this lecture/workshop; however, participants who are enrolled in this course will be expected to attend the lectures in **Elementary Mathematics for Social Scientists** as well as the lecture/workshop, **Introduction to Statistics and Data Analysis**. This four-week course is designed to be an intensive practical introduction to the use of quantitative methods in historical research. Topics of discussion will include various elements of the research process; in particular, problem definition, experimental design, data collection and preparation, numerous methods of analysis, and interpretation of results. Much attention will be devoted to determining important sources of quantitative or quantifiable historical data, including census materials, biographical data, election returns, and legislative roll call records. In addition, participants will examine the development and utilization of quantitative exercises for instructional purposes, with special emphasis centered on the utility of incorporating quantitative analysis in the undergraduate history curriculum. (NOT OFFERED IN 1980)

Quantitative Historical Analysis II (Lecture/workshop: 3 credits) Participants who enroll in this lecture/workshop should have a general knowledge of the scope and method of social research, including knowledge of problem formation, research design, sampling, and data collection procedures, and should have had at least one course in applied statistics. The focus of this intermediate-level course will be the use of statistical and other data analytic methods for exploring the nature of historical phenomena. Of particular importance will be the methods of contingency table analysis and linear regression and correlation; however, the instructional strategy will be that of conveying technical information to students within the context of an intensive exploratory data analysis experience. The level of the technical discourse will be approximately that of Blalock's *Social Statistics* (2nd edition).


Introduction to Statistics and Data Analysis I
Introduction to Statistics and Data Analysis II
Introduction to Linear Models
1. Applied Multivariate Analysis
2. Applied Nonparametric Statistics
3. Experimental Studies
4. Exploratory Data Analysis
5. Multi-level Analysis
Intermediate Linear Models
Mathematics for Social Scientists
1. Advanced Linear Models
2. Causal Models
3. Discrete Multivariate Analysis
4. Models with Unmeasured Variables
5. Multivariate Dimensional Analysis
6. Time Series Analysis

Database Management for Complex Data Sets (Workshop: no credit) Students in this one-week, intensive workshop will share knowledge of problems and techniques of computer-assisted database management for large complex data collections involving different time periods, different data sources, and different levels of analysis. Course content will include examination of existing database management systems, and much time will be devoted to exploring problems and solutions of specific interest to the participants. Enrollment will be limited.

Data Management, Library Control, and Use of Computer Readable Information (Workshop: no credit) While there are no formal methodological or computing prerequisites for this course, each participant should have had some practical experience as a data librarian. This one-week workshop is designed for individuals whose responsibilities include provision of data services or information about computer-readable social science data files to users of those resources. The objective of the workshop is to introduce practitioners to data management, data control, and data servicing procedures and techniques. Data library procedures and user services, including acquisition of data, transfer of data, accessioning data, and bibliographic control, will also be reviewed. An intensive study format will be employed for this workshop. (NOT OFFERED IN 1980)

Introduction to Computing with SPSS (Workshop: no credit) Although there are no formal prerequisites for participation in this workshop, it would be of no utility at all for a student whose background did not include an applied statistics course such as the Consortium's **Introduction to Statistics and Data Analysis I and II**. The purpose of this four-day workshop is to introduce the student to the Statistical Package for the Social Sciences (SPSS) programs. All relevant topics will be motivated by exposing participants to "hands on" computing experiences utilizing a set of guided exercises. The content of the workshop will include a potpourri of topics sampled from the *SPSS Manual* (2nd edition).

Asian American Research Methods Workshop (Lecture/workshop: no credit) Participants who take this workshop should have already had the equivalent of or should be enrolled in **Introduction to Statistics and Data Analysis I and II**, should have a substantive interest in research related to Asian Americans, and should have at least a rudimentary knowledge of computing. They will be expected to use the workshop to explore research problems in which they have specific interest. This two-week workshop will be preceded by one of several four-week course sequences offered by ICPSR; however, full participation in the ICPSR Training Program is optional. The workshop will focus on methodological problems of research related to Asian Americans, including availability of relevant data, survey problems, sampling Asian American populations, and problems related to bilingual instrumentation. Participants will analyze data developed jointly by ICPSR and the Pacific/American Mental Health Research Center. Senior Asian American scholars will be invited to Ann Arbor to interact with participants near the end of the two-week period. Enrollment will be limited to fifteen students, preferably those having post-doctoral status, and stipend support will be provided for those admitted to the program.

Participants should understand that lecture/workshops form the core of the Training Program's curriculum, *and credit at the University of Michigan may be obtained only for those courses*. The various lecture series are an important and integral component of the participant's experience; however, their purpose is to broaden and enrich the student's *primary* intellectual activities which should focus on participation in lecture/workshops. Consequently, students should determine their programs of study by choosing those lecture/workshops in which they are interested, and their schedules should be completed by augmenting that nucleus of courses with selections from the list of lecture series.

Naturally, each participant's schedule of courses will be tailored to his/her individual needs. A few prototypes of students' schedules are presented below, solely for the purpose of providing some notion of what constitutes a reasonable commitment for an eight-week program of studies.

Participant A (This individual has had a course in Scope and Methods of Social Research):

First Session:	Elementary Mathematics for Social Scientists Introduction to Statistics and Data Analysis I* Introduction to Computing
Second Session:	Data Analysis and Public Policy Experimental Studies* Introduction to Statistics and Data Analysis II* or Introduction to Linear Models*

Participant B (This individual has had an applied statistics course at approximately the level of Hays' *Statistics for the Social Sciences* (2nd edition):

First Session:	Mathematics for Social Scientists Dynamic Analysis Evaluation Research Methodology Introduction to Computing (if necessary) Intermediate Linear Models*
Second Session:	Data Analysis and Public Policy Exploratory Data Analysis* Applied Multivariate Analysis* or Multi-level Analysis*

Participant C (This student has had an applied statistics course at at least the level of Hays' *Statistics for Social Scientists* (2nd edition), has a grasp of the notion of a linear model at approximately the level of Wonnacott and Wonnacott's *Econometrics*, and is knowledgeable of the basic principles of matrix algebra):

First Session:	Mathematics for Social Scientists (if necessary) Formal Theories of Social Research Introduction to Computing (if necessary) Applied Multivariate Analysis* or Advanced Linear Models*
Second Session:	Data Analysis and Public Policy Dynamic Models of Political Economy Causal Models,* Exploratory Data Analysis,* or Models with Unmeasured Variables* Discrete Multivariate Analysis* or Time Series Analysis*

Needless to say, each participant may elect to take a rich schedule of lectures, workshops, and lecture/workshops during the summer term. In fact, so many intellectual opportunities are available for students that they are often tempted to spend their time at the Consortium's Training Program dashing from one course to another, filling each day with a potpourri of activities and committing themselves to nothing in particular. While even that strategy may be optimal for a few individuals, participants who fail to devote their attention to an intensive study of a restricted set of intellectual ideas, truly miss much of the focus and value of the Training Program.

*This is a course for which graduate credit at the University of Michigan may be earned.

TUITION FEES

With the exception of those who have Visiting Scholar status, or participants who matriculate in a few of the special programs or the short courses, University of Michigan tuition fees are required of everyone who attends the Training Program. For computing tuition costs, assume that two ICPSR summer terms count as only one University of Michigan summer term.

Enrollment Status	Michigan Resident	Non-resident
Graduate Credit or Special Credit (Summer Guest)		
3 credit hours	$312	$ 684
5 or more credit hours	$467	$1,022
Special Auditor		
Any number of credit hours (first and/or second sessions)	$125	$ 375

Please note that all fees are subject to change at any time by the Board of Regents of the University.

HOUSING

The following guidelines for finding suitable summer housing accommodations in Ann Arbor have been used effectively by participants for several years.

Participants usually obtain housing in University residence halls, in University and privately owned apartments, or in privately owned, furnished rooms. Some homes are also available as summer sublets. If it is at all possible, it may be useful to discuss housing arrangements in Ann Arbor with former participants, but remember that it is likely that the cost of living will have increased over the years. Although housing costs may be your primary concern, you should also consider such factors as access to public transportation, air-conditioning, the desirability of dorm life, etc. It is very difficult to find housing in Ann Arbor that includes accommodations for pets.

Generally, family housing is the most difficult to find. If you intend to bring your family to Ann Arbor and if you will attend classes for the entire eight-week period, the University of Michigan offers housing at a reasonable price, but early application is essential. A reasonably priced apartment for a single individual is somewhat difficult to find, but is usually easier to locate shared housing. You should decide whether to make housing arrangements prior to your arrival in Ann Arbor. Some former participants recommend waiting to find "a bargain" after classes begin. In the past, individuals willing to share an apartment have had little difficulty making such arrangements; however, some effort, including telephoning and occasionally some footwork, is required. Listings can be found in the *Ann Arbor News* or on fliers posted outside the Housing Office on the first floor of the Student Activities Building. All caveats aside, it is noteworthy that participants invariably find satisfactory housing without much difficulty.

In writing for housing, mention the name of the Program (ICPSR Summer Training Program) and the dates (June 30-August 22). There is often some confusion about schedules, because the University of Michigan has a 15-week Spring/Summer term and a Spring half-term which overlap the eight-week ICPSR Training Program schedule.

APPLICATIONS

Application for participation in the ICPSR Training Program consists of two separate steps.

1. Application to attend the ICPSR Training Program:
   Admission to the Training Program is determined under guidelines set by the ICPSR Council. Applicants should contact the Consortium's Official Representative at their home institution to obtain the ICPSR application form. Completed applications must reach the office of the Training Program's Director by April 15, 1980, and applicants will be notified regarding their acceptance into the Program by the end of April, 1980.

2. Application to attend The University of Michigan:
   Application procedures for admission to the University of Michigan are described below. Admission to the University should be obtained subsequent to admission to the ICPSR Training Program.

ADMISSION STATUS

All non-University of Michigan participants in the ICPSR Training Program must be admitted by the University of Michigan under one of the three categories listed below. *Applicants should indicate their desired status on the application to the ICPSR Training Program.* Upon admission to the Program, the Training Program office will forward University of Michigan application forms to prospective participants along with relevant instructions.

1. Visiting Scholar. Individuals who have the Ph. D. degree or its equivalent or who have an academic appointment at the rank of Associate Professor or higher at an accredited institution, and who do not wish to have a record of their work on file, may request "guest" privileges, enabling them to attend the Training Program and use University facilities without charge. A copy of the Ph. D. diploma, a transcript, or an official letter from the institution that awarded the Ph. D. degree must be submitted to ICPSR along with the completed application in order for an applicant to be granted Visiting Scholar status.

   Furthermore, prospective participants who have completed all requirements for the Ph. D. degree, but who have not formally received the degree, may apply for Visiting Scholar status. Such participants must request that their department chairperson send a letter to the ICPSR office confirming that all degree requirements have been met and stating the date upon which the degree will be conferred. This letter must be included with the completed application form.

2. Special Credit Student. (Summer Guest) Students with a Bachelor's degree who wish to receive academic credit for participation in the Training Program may apply for admission to the Graduate School of the University of Michigan as special credit students.

3. Special Auditor. Students who do not intend to enroll in courses in the Summer Program for credit, and who do not qualify as Visiting Scholars, must apply for admission as special auditors. Note that with this academic status no university record of the student's performance will be kept on file.

It is possible for individuals who qualify under the Committee on Institutional Cooperation (CIC) traveling scholar program to participate in the Training Program under the CIC guidelines.

Appendix Seven

A MATHEMATICAL SYSTEMS DEPARTMENT IN A TEACHING UNIVERSITY

Based on Information Provided in

1980-81 GRADUATE CATALOG
SANGAMON STATE UNIVERSITY
SPRINGFIELD, ILLINOIS

Prepared By

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(Tel. #800-848-4815)

For Discussions Regarding
THE MATHEMATICAL SCIENCES IN VOCATIONAL EDUCATION
LEADERSHIP DEVELOPMENT PROGRAMS
(A 1980 Advanced Study Center Project)

(December 1980)

SANGAMON STATE UNIVERSITY

(Institutional Statements)

PHILOSOPHY AND PURPOSE

Sangamon State is an upper-division and graduate university committed to a concept of higher education that compels it to reach out into the community and respond in meaningful ways to the needs of today's students and the demands of contemporary society. The mandate of the university is to address public affairs within the framework of a liberal arts curriculum and to stress practical experience. professional development, and innovative teaching.

Continuing the philosophy of open admission and affirmative action generated by the state's community colleges, Sangamon State provides opportunities for upper-level and graduate education to a broad spectrum of students: transfer, individuals resuming an interrupted education, employed persons seeking to upgrade themselves in their current positions or to prepare for second careers, and area residents wishing to enhance their personal lives.

As the public affairs university for the state of Illinois, Sangamon State addresses itself to specific and general needs of government and society through special courses, projects, and student internships. The university also prepares people for public service and fosters an active understanding of social environmental, technological, and ethical problems as they relate to public policy.

Faculty members of Sangamon State University have a commitment to the individual student; excellent teaching is the faculty's highest priority, and research and publication serve as support for teaching. Many classes are small and informal and permit easy relationships between students and professors. Faculty members also serve as students' academic advisers. The adviser acts as a central contact and helps the student develop a meaningful and enriching program of study.

Many of Sangamon State University's academic programs are designed to bring together the world of public affairs and the world of higher education. The task is to teach people and prepare them as individuals to be effective participants in a changing society.

PUBLIC AFFAIRS AT SANGAMON STATE UNIVERSITY

As the public affairs university in the Illinois state system of higher education, Sangamon State directs educational, research, and service efforts toward solution of public problems facing the state and its local communities. Emphasis is on a coordinated, interdisciplinary approach to problem-solving, training, and communication through the following centers and services:

The Illinois Legislative Studies Center. the Center for Policy Studies and Program Evaluation, the Center for the Study of Middle-Size Cities, and the Legal Studies Center.

Each center and service program is charged to develop applied research and service activities which effectively address problems of state and local significance. Each unit has a small permanent core of faculty with joint appointments in the center and in an academic program. Specific projects draw additional staff from among the faculty who are temporarily attached to the unit; both groups of faculty members have teaching and other obligations during the period of their assignment to the project. This linkage serves to bring faculty members' public affairs experience to the classroom and provides a flexible staffing pattern which matches relevant faculty expertise to public problems and helps to ensure maximum benefit for instructional programs.

Sangamon State awards the following degrees:

Master of Arts in Business Administration, M.A.B.A.
Master of Public Administration, M.P.A.
Master of Science, M.S.
- Nutrition

Master of Arts, M.A.
- Biology
- Child, Family, and Community Services
- Communication
- Community Arts Management
- Economics
- Educational Administration
- Environments and People
- Gerontology
- Helath Services Administration
- History
- Human Development Counseling
- Individual Option
- Legal Studies
- Literature
- Mathematical Systems (four Concentrations)
  - Computer Science
  - Mathematics
  - Operations Research/Systems analysis
  - Statistics
- Political Studies
- Public Affairs Reporting
- Psychology
  - Clinical Psychology
- Sociology/Anthropology
- Social Justice Professions (three concentrations)
  - Administration of Justice
  - Human Services
  - Law Enforcement

Center for Policy Studies and Program Evaluation

SANGAMON STATE UNIVERSITY

(Institutional Statements)

The Center for Policy Studies and Program Evaluation contributes to the public affairs mandate of Sangamon State University through a broad range of programs designed to help imprive governmental performance in Illinois, particularly at the state governmental level. Started in 1972-73 informally as the Public Sector Evaluation Center, and formalized by the Board of Regents in the following year, the center's activities were expanded in 1976 to encompass its present scope of concern for the broad range of policy formulation and policy implementation processes.

In carrying out its mandate, the center conducts four main types of program activities: Problem-solving research; technical assistance consultations; training programs; and a public sector internship program.

Center research activities include independent studies of major public problems facing Illinois as well as research undertaken at the request of governmental units. Research activity is applications oriented, emphasizing the use of rigorous analysis to clarify public issues and possible policy alternatives, while also developing new, generalizable knowledge about governmental and other public sector organizations on internal managerial issues as well as policy-making and implementation questions. Management training and executive development activities include individual consultations, workshops and conferences, specialized courses, training needs assessments, and long-term development strategies.

Within the center, the Graduate Public Service Internship program contributes significantly to both the problem-solving mission of the center and to the broader educational mission of the university. Interns from a wide range of colleges and universities in Illinois serve with a variety of state executive branch departments and agencies. The internship program allows a student to work one-half time in a state agency while completing work on a two-year graduate degree in a field such as public administration, business administration, economics, mathematics, human development counseling, social justice, political studies, and health services management. During the school year the agency provides funds to the university to pay the student a monthly stipend plus tuition costs and professional development travel. During the summer period the intern works full time in the agency.

As a public affairs university, Sangamon State has a dual mission to fulfill--extending the resources of the university outward through public service activities, and furthering the unique mandate of academia to advance understanding of man and his world. Both missions--service and understanding--provide the underlying purpose for the center's work. Interplay between these two missions is essential to fulfill the unique contributions the center can make to improve governmental performance in Illinois. Public service activities which are unguided by the academic concern for increased understanding are incomplete. Likewise, academic quests for understanding of our governing system without enrichment from the practical experiences of public service work are also incomplete. The center's mandate is thus to help bridge the knowledge-action gap between the academic understanding of government and the practice of government.

Illinois Legislative Studies Center
SANGAMON STATE UNIVERSITY
(Institutional Statements)

This center coordinates university activities related to the Illinois General Assembly, including experiential education, applied research, and public service.

The Illinois Legislative Staff Internship Program, the Illinois Private Sector Internship Program, and the Applied Legislative Study Term are major educational components of the ILSC. The Legislative Staff Internship Program, which provides an opportunity for outstanding graduate students from throughout the state to serve with leadership or nonpartisan research agency staff for a period of nine and a half months beginning Oct. 1, is coordinated for the Illinois Legislative Council by the center. The Private Sector Program is also a nine-and-a-half months graduate-level experience, but interns are placed on legislative staffs of private associations which supply funding.

Applied research projects of the center are generally directed toward questions of public policy or legislative processes and afford both students and faculty the opportunity to conduct research and study in the legislative setting.

Public service activities have included sponsorship of conferences and training sessions for legislators, legislative staff, and associated professionals.

The center publishes a monograph series which reports the research projects and conferences conducted under its auspices.

Center for the Study of Middle-Size Cities
SANGAMON STATE UNIVERSITY
(Institutional Statements)

The Center for the Study of Middle-Size Cities was established to address problems and issues common among cities with populations in the range of 50,000 to 250,000. Although much research has been conducted on numerous aspects of the nation's largest metropolitan areas, the findings are seldom relevant to or in a form useful to cities of lesser size. Moreover, few middle-size cities have developed the capacity to conduct applied studies of the broad-range problems and issues relevant to their particular interests. Consequently, many have difficulty in responding effectively to the increasing magnitude of economic, social, environmental, and governmental problems.

The major objective of the center is to serve the interests of middle-size cities by:

Conducting interdisciplinary, comparative, applied, and policy-oriented research on a wide variety of issues. Research has been done in the areas of energy consumption analysis, health services delivery systems, transportation feasibility studies, public opinion polls, and criminal justice.

Serving as an information and consulting resource center to assist social agencies, local governments, and public and private organizations in their efforts to improve the quality of life and government of their communities.

Gathering, organizing, and presenting information about middle-size cities in workshops and seminars for students at the university and for interested groups and organizations throughout the state.

The Center for Legal Studies

SANGAMON STATE UNIVERSITY

(Institutional Statements)

The Center for Legal Studies has been developed to serve Sangamon State's public affairs mandate in three basic ways: 1) to coordinate the clinical education aspects of the legal studies degree programs; 2) to develop and deliver a program of law-related training; and 3) to engage in applied research activities. The Illinois Board of Higher Education has also given the center responsibility for administering the educational component of a courts complex which is being planned for the Circuit Court of Sangamon County and the Fourth District Appellate.

Many legal studies students have been successful in finding a variety of public and private law-related positions under the auspices of internship and applied study programs administered by the center. Supervision of clinical education provides information which is useful for program planning and career placements. One of the center's continuing interests is to study ways to increase the use of legal assistants in the public service.

The center is active in the development of law-related training programs which expand general knowledge about the law and provide in-service legal training for persons working in public agencies. These include: 9) summer workshops on law-related education for secondary education teachers; 2) a probation training program which is a significant factor in efforts to improve the quality of the state's professional probation workers; 3) training programs for persons working with juvenile-status offenders; 4) in cooperation with state, local, and private agencies, initiation of a series of interdisciplinary workshops to improve communication between volunteers and professions who seek to divert juvenile offenders from the court process; and 5) in cooperation with the University of Illinois and the Illinois Department of Children and Family Services, development of a legal training curriculum and workshops for state social workers dealing with abused and neglected children.

The center's main research interests, rural justice and the legal system in Illinois, provide the basis for applied and scholarly research projects intended to produce data for judicial policy development as well as theoretical information for reference, publication, and further research. A recent in-depth survey of Illinois circuit court clerks and a current study of Illinois trial court judges will be important contributions to a better understanding of the legal system in Illinois, as it pertains to the delivery of rural justice.

The training, clinical education, and research activities of the center provide Sangamon State students with many opportunities to supplement academic activities with practical experience.

SANGAMON STATE UNIVERSITY

Mathematical Systems

M.A.
(40 Hrs.)

PROGRAM FACULTY — D. Anton Florian, K. G. Janardan, Philip Koltun, King Lee, Mary Kate Yntema.

ASSOCIATED FACULTY —Harry Newman, Richard Newman.

To meet the ever-increasing demand for diverse quantitative skills, the Mathematical Systems Program offers courses in four areas of basic and applied mathematics: mathematics, statistics, computer science, and operations research.

A student who plans to do graduate work in any area of mathematics, science, or engineering, or who wishes to pursue a career in teaching, will probably choose to take most courses in pure mathematics. The student concentrating in statistics will learn to use and apply statistical techniques to real-life problems, and will acquire the skills of collection, tabulation, analysis, and interpretation of data needed to provide the quantitative information used in a modern technological society. Computer science at Sangamon State deals solely with software (development of the program that controls the machine) rather than hardware (the machine itself). Students are trained to design and analyze small-scale and/or large-scale computer systems and to design and implement the required systems programs. Usage of an outstanding variety of interactive and batch-processing computing systems—including an IBM 360/75, CDC Cyber 72, and an HP 3000—is integrated into the curriculum. Operations research deals with the application of mathematics to solve complex problems of human organizations. Students in this area analyze decision and control problems involving the interaction of many factors and organizational components; construct mathematical, economical, and statistical descriptions or models of these problems; derive solutions from these models; and test and implement the solutions.

Students are not restricted to concentrating in one of the four areas of the Mathematical Systems Program; they may choose courses from different areas to fit their individual interests. Such students may matriculate after they have worked out a plan of study with an adviser, and after the plan has been approved by the mathematical systems program committee.

ADMISSION

All mathematical systems students are expected to have had a year of calculus before entering the program, and must demonstrate their proficiency by passing a test administered by the program each year. Students who have not studied calculus may prepare for the test by taking MSU 409, and completing additional modules designed for the test. Students must pass their test before matriculation. In addition, each concentration within the Mathematical Systems Program has specific matriculation requirements.

ADVISING

Prior to registration for the first time, the student should discuss with the program convener or any member of the mathematical systems faculty, the courses to be taken during the student's first semester at SSU. After classes begin, he or she is urged to choose a permanent adviser as soon as possible. Normally, the adviser will be associated with the concentration in which the student will be matriculated.

COMMUNICATION SKILLS

Before graduation each student will undertake a graduation project, which includes a written report, as one of the required courses. This report will be graded not only on content, but also on organization and clarity of expression. All students are required to take a diagnostic test on their communication skills at the Learning Center early in their studies. Those needing help will be counseled accordingly.

GRADING POLICY

An acceptable grade for graduate students is normally an A or B grade. A grade of C may be counterbalanced by a grade of A in an MSY course at the same level or higher (i.e., a C grade in a 500-level course may be counterbalanced only by an A grade in a 500-level course).

PROGRAM REQUIREMENTS

The Mathematical Systems Program consists of four concentrations: Mathematics, Statistics, Computer Science, and Operations Research/Systems Analysis. A student may graduate after fulfilling the requirements of one of these concentrations. In addition, a student may design an individualized program combining features from several concentrations in consultation with an adviser; this program of study must be approved by the mathematical systems program committee to assure its coherence.

The matriculation requirement is given for each concentration separately. Students who fail to matriculate are so notified by the program convener. They may appeal this decision to the program up to the end of the semester in which they are notified.

MATHEMATICS CONCENTRATION

A student may matriculate after:

1. Completing the equivalent of MSY 411; MSY 412; MSY 413; MSY 415.
2. Completing eight hours of graduate work in MSY courses at SSU with a grade of B or better.
3. Passing the calculus examination.
4. Taking the communications skills diagnostic test.

An M.A. in mathematics involves 40 semester hours of graduate-level work, of which 32 hours must be in MSY courses. Of the 32 hours of MSY courses, 12 hours must be at the 500 level. Well-prepared students having had the equivalent of MSY 411 and 412 Linear Algebra, MSY 413 Abstract Algebra, and MSY 415 Advanced Calculus may waive 10 hours.

The general university requirement of a graduation project may be satisfied by taking MSY 518. This course requires the student to develop a presentation, in writing and orally, of some aspect of mathematics not formally studied in class. The topic and presentation should demonstrate the student's ability to bring together, in a coherent fashion, theory from different mathematical fields.

OPERATIONS RESEARCH/SYSTEMS ANALYSIS CONCENTRATION

MSY 470 OPERATIONS RESEARCH/SYSTEMS ANALYSIS PRACTICUM **(1-4 Hrs.)**
Guided field experience in applying operations research and systems analysis techniques to a real problem. Description of current projects available from instructor. No prior experience necessary. May be repeated for maximum of 8 hours. Offered fall and spring.

MSY 472 CONSTRUCTION OF DETERMINISTIC OPERATIONS RESEARCH MODELS **(2 Hrs.)**
Construction and application of standard deterministic models in operations research. Includes linear programming, nonlinear programming, network analysis, inventory, models, and dynamic programming. Offered in fall.

MSY 473 CONSTRUCTION OF PROBABILISTIC OPERATIONS RESEARCH MODELS **(2 Hrs.)**
Construction and application of models which involve use of probability and statistics. Topics include queueing theory, inventory models, Markov processes, reliability, and simulation. Knowledge of calculus, probability, and statistics required. Offered in spring.

MSY 474 SOLUTION OF DETERMINISTIC OPERATIONS RESEARCH MODELS **(2 Hrs.)**
Methods for deriving solutions from standard deterministic models discussed in MSY 472. Prerequisites: MSY 472 or equivalent and calculus. Offered in fall.

MSY 475 SOLUTIONS OF PROBABILISTIC OPERATIONS RESEARCH MODELS **(2 Hrs.)**
Methods for deriving solutions from standard probabilistic models discussed in MSY 473. Prerequisite: MSY 473 or equivalent. Offered in spring.

MSY 480 SEMINAR IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS **(1 Hr.)**
Recent advances in operations research. Open to students concentrating in OR/SA. Maximum of 2 hours may be applied to degree.

MSY 481 LINEAR PROGRAMMING **(4 Hrs.)**
Theory underlying linear programming methods. Includes simplex procedure, duality, sensitivity analysis, and integer programming. Problems are formulated and solved through use of existing computer codes. No prior knowledge of linear programming or computer programming required. Knowledge of algebra required.

MSY 483 FORECASTING **(4 Hrs.)**
Techniques of forecasting and their application. Linear regression models, time series analysis including Box-Jenkins and other more advanced techniques, exponential smoothing. Prerequisites: MSY 422 or equivalent and calculus.

MSY 485 SYSTEMS SIMULATION **(4 Hrs.)**
Monte Carlo techniques, random numbers and random deviate generation, variance reducing techniques, and applications. Knowledge of statistics and computer programming required.

MSY 570 OPERATIONS RESEARCH/SYSTEMS ANALYSIS PRACTICUM **(4 Hrs.)**
Final practicum of each OR master's candidate, bringing all previous study to bear on one advanced problem of practical significance.

MSY 580 ADVANCED TOPICS IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS **(4 Hrs.)**
Advanced topics from literature of operations research and systems analysis. May be repeated for indefinite number of credit hours, but particular topic may not be repeated for credit.

MSY 581 QUEUEING THEORY **(4 Hrs.)**
Structure and basic theory of queues, Poisson queues, non-Poisson queues, renewal theory, and applications. Prerequisite: calculus and statistics.

M.A. degree students may take the following course as part of their concentration in the OR/SA Option.

ACC 421 Administrative Uses of Accounting Information

COMPUTER SCIENCE CONCENTRATION

MSY 451 COMPUTER FUNDAMENTALS AND PROGRAMMING I (2 Hrs.)
Introduction to programming in a higher-level language such as Pascal. Emphasizes structured programming techniques. Students may not take both MSY 451 and MSU 414 for credit.

MSY 452 COMPUTER FUNDAMENTALS AND PROGRAMMING II (2 Hrs.)
Continuation of MSY 451. Students may not take both MSY 452 and MSU 415 for credit.

MSY 453 COMPUTER ARCHITECTURE (4 Hrs.)
Internal computer organization, general computer addressing methods, general internal data representation. OS/370 assembly language programming with macro facilities, micro programming, subprogram structure and linkage, coroutines, general data management, basic systems programs. Prerequisite: ability to program in a higher-order language. Lecture/laboratory course.

MSY 454 INFORMATION STRUCTURES (4 Hrs.)
Basic data organization, list structures, strings, arrays, tree structures, computer storage management, memory allocation and collection, sorting table construction and searching, programming language data structures. Prerequisites: MSY 451 and MSY 452 or equivalent.

MSY 455 STRUCTURE OF PROGRAMMING LANGUAGES (4 Hrs.)
Comparative anatomy of programming languages, data structures, central structures, run-time implementation and environment, and their relation to design criteria. Language acquisition techniques. Use of APL, Basic, and Snobol, among others.

MSY 457 COMPILER ARCHITECTURE (4 Hrs.)
Syntax analysis, symbol table construction, object code generation, optimization techniques, boot-strapping, compiler-compilers. Prerequisites: MSY 454 and 455 or equivalent.

MSY 459 DATA BASE MANAGEMENT (4 Hrs.)
Presentation and appraisal of the technology and practice of Data Base Management Systems. Prerequisite: MSY 454.

MSY 460 TOPICS IN COMPUTER SCIENCE (4 Hrs.)
Topics vary. May be repeated for an indefinite number of hours.

MSY 461 OPERATING SYSTEMS PRINCIPLES (4 Hrs.)
Batch multiprogramming, real-time, and time-sharing concepts; job and task management; storage management; data management; linkage editors; resource allocation. Prerequisite: MSY 454 or equivalent.

MSY 462 SYSTEMS PROGRAMMING LABORATORY (4 or 8 Hrs.)
Design and implementation of a complete software system: basic operating system, assembler, loaders, utilities, program language compiler. Prerequisite: MSY 457 and MSY 461 or equivalent. Lecture/laboratory course.

MSY 465 LEGAL ISSUES IN COMPUTING (4 Hrs.)
Topics include contracting for computer services; liability for programming errors; taxation of computer systems; protection of proprietary software; privacy and data-banks; electronic funds transfer systems; information utilities; and government regulation of the computer industry.

MSY 553 STRUCTURED PROGRAMMING (4 Hrs.)
Systematic examination of literature on structured programming concepts. Other topics include modular programming, software project management, documentation, and confirmation of program correctness. Languages designed to encourage structure programming, such as Pascal, are utilized. Prerequisite: knowledge of some higher-level language.

MSY 555 COMPUTER GRAPHICS (4 Hrs.)
Operation of graphic-devices, picture models and data structures, display software. Prerequisite: MSY 454 or equivalent.

MSY 557 DATA COMMUNICATIONS (4 Hrs.)
General communication concepts, transmission control hardware, telecommunication software, network design and control. Prerequisite: MSY 461 or equivalent.

MSY 561 LARGE-SCALE COMPUTER SYSTEMS (4 Hrs.)
Advanced computer architecture: virtual memory, multiprocessors, array processors (ILLIAC IV), string and array processors (CDC STAR 100), associate memory systems. Prerequisite: MSY 461 or equivalent.

MSY 563 ADVANCED OPERATING SYSTEMS (4 Hrs.)
Analysis of large operating systems: OS/MFT, OS/MVT, OS/VS, Burroughs MCP, CDCSCOPE. Prerequisite: MSY 561 or equivalent.

MSY 565 PERFORMANCE EVALUATION SEMINAR (4 Hrs.)
Tools and techniques for performance evaluation of computer systems. Integrated hardware/software systems, user programs, and systems programs considered. Prerequisite: functional knowledge of operating system principles and computer architecture. Prerequisite: MSY 454.

MSY 569 INDIVIDUAL PROJECT (4 Hrs.)
Final exercise of each computer science Master of Arts candidate, bringing all previous study to bear on one advanced problem. Laboratory course.

MSY 440 TOPICS IN STATISTICS (4 Hrs.)
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours.

MSY 441 STATISTICAL DESIGN AND ANALYSIS (4 Hrs.)
Fundamental principles of design, completely randomized experiments, randomized blocks, Latin squares, Graeco-Latin squares; cross-over designs; split plot designs; fractional experiments, complete and partial confounding; fractional replication, experimental and sampling errors, and components of variance and co-variance. Prerequisite: MSY 422 or equivalent.

MSY 450 TOPICS IN PROBABILITY (4 Hrs.)
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours. Prerequisite: MSY 421.

MSY 535 MATHEMATICAL STATISTICS I (4 Hrs.)
Techniques for obtaining and using information in the presence of uncertainty. Includes probability distributions, exact and limiting sampling distributions, principles and methods of estimation, order statistics. Prerequisites: MSY 415, MSY 425 or equivalents.

MSY 536 MATHEMATICAL STATISTICS II (4 Hrs.)
Continuation of MSY 535. Point estimation of one parameter; sufficiency and completeness; maximum likelihood estimation; hypotheses testing; Neyman-Pearson Lemma and uniformly most powerful tests; analysis of variance and certain nonparametric methods. Prerequisite: MSY 535 or equivalent.

MSY 537 STATISTICAL ECOLOGY (4 Hrs.)
Ecological problems and statistical distributions. Includes discrete and continuous distributions; construction of models in scientific work—sampling models, models for birth and death processes for both counts and inter-event times, multivariate models, interrelations and structures, estimation, and tests. Prerequisite: MSY 425 or equivalent.

MSY 538 SAMPLING TECHNIQUES (4 Hrs.)
Derivation of standard results of finite population sampling theory. Includes simple and stratified random sampling, systematic sampling, multistage sampling, regression, and ratio estimation. Effect of costs on sample allocation. Prerequisite: MSY 425 or equivalent.

MSY 539 ENVIRONMENTAL DATA ANALYSIS (4 Hrs.)
Material is centered around live problems. Topics include statistical properties of environmental data; characteristics and parameters of quality; distributions of parameters of environments; sources and magnitude of errors. Flexible format, with combination of lectures, seminars, and projects.

MSY 540 SEMINAR IN STATISTICS (1-4 Hrs.)
Topics vary. May be repeated for an indefinite number of hours.

MSY 543 APPLIED STOCHASTIC PROCESSES (4 Hrs.)
Bernoulli and Poisson processes, Markov chains and processes, birth and death process, and time dependent stochastic processes. Suitable for students in business, economics, and any option of the Mathematical Systems Program. Prerequisite: MSY 425 or equivalent.

MSY 544 DISTRIBUTION THEORY (4 Hrs.)
Probability distributions arising in statistical inference. Univariate and multivariate distributions. Properties of distribution functions and characteristic functions. Important limit theorems. Prerequisite: MSY 425 or equivalent.

MSY 545 LINEAR STATISTICAL MODELS (4 Hrs.)
Quadratic forms, linear hypothesis models, hypothesis tests, regression, analysis of variance and co-variance, fixed and random effects models, multiple comparisons, designs. Prerequisite: MSY 425 or equivalent.

MSY 546 MULTIVARIATE ANALYSIS (4 Hrs.)
Properties of the multivariate normal distribution. Sampling distributions and tests in multiple correlation and regression, Hotelling's T statistic, discriminant analysis, multivariate normal variable. Canonical correlation and principle component analysis. Prerequisite: MSY 425 or equivalent.

MSY 549 GRADUATE PROJECT (1-4 Hrs.)
In area of statistics to be decided upon with instructor. A written report and an oral presentation required.

MSY 550 SEMINAR IN PROBABILITY (1-4 Hrs.)
Topics vary. May be repeated for an indefinite number of hours.

MSY 508 COMPUTABILITY (4 Hrs.)
Turing machines, universal Turing machines; the halting problems; Godel numbering; unsolvability; recursive sets and functions; recursively enumerable sets; decision problems and undecidability. Prerequisite: MSY 407 or equivalent.

MSY 510 ADVANCED TOPICS IN ALGEBRA (1-4 Hrs.)
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours.

MSY 518 GRADUATE PROJECT (1-4 Hrs.)
In area of mathematics decided upon with instructor. A written report and an oral presentation required.

MSY 519 COMPLEX ANALYSIS (4 Hrs.)
Discussion of the complex plane, complex functions, Cauchy-Riemann equations, Taylor and Laurent expansions, contour integration, and conformal mapping. Prerequisite: MSY 415 or equivalent.

MSY 520 ADVANCED TOPICS IN ANALYSIS (4 Hrs.)
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours. Prerequisite: MSY 415.

STATISTICS CONCENTRATION

MSY 421 PROBABILITY AND STATISTICAL APPLICATIONS (2 Hrs.)
Definitions of probability; algebra of events, addition and multiplication rules; permutations and combinations; random variables and probability distributions; expected value of a random variable; some common statistical distributions. Statistical applications of probability via binomial model—prediction and decision-making.

MSY 422 STATISTICAL ANALYSIS (2 Hrs.)
Presentation of data; numerical description; discrete and continuous random variables; uniform exponential and normal distributions; statistics, and sampling distributions; central limit theorem; students t, chi-square, and F-distributions; ideas of estimation and testing of hypothesis for normal populations; confidence interval estimates; concepts of regression and correlation. Prerequisite: MSY 421.

MSY 425 STATISTICAL INFERENCE (4 Hrs.)
Random variables and their distributions; moment generating functions; central limit theorem; important statistics; distributions of certain statistics; basic ideas of inferential statistics; estimation and tests of significance with special emphasis on treatment of actual data; goodness of fit tests. Prerequisites: MSY 421 and MSY 422.

MSY 428 DISCRETE STATISTICAL MODELS AND METHODS (4 Hrs.)
Systematic study of probability models and statistical models pertaining to statistical analysis of data consisting of single and multiple counts. Prerequisite: MSY 421 or equivalent.

MSY 429 DYNAMIC PROBABILISTIC SYSTEMS ANALYSIS (4 Hrs.)
Analysis of probabilistic systems which are dynamic in time with aid of theory of probability and stochastic processes. Includes Markov processes; recurrent events; general random processes and their applications to analysis of various systems in business, economics, ecology, and sciences. Prerequisite: MSY 421 or equivalent.

MSY 436 APPLIED MULTIVARIATE ANALYSIS (4 Hrs.)
Introduction to multivariate statistical methods; multiple regression and correlation, principal components, anonical correlations, partial correlations, discriminant and factor analysis. Concentrates on methods of data analysis using computer packages rather than traditional theoretical approach. Suitable for the social science student as well as the statistics major. No prior knowledge of computer programming required. Prerequisite: MSY 422.

MSY 437 APPLIED REGRESSION ANALYSIS (4 Hrs.)
The simple linear regression model, developed and extended to multiple linear regression, polynomial regression, and stepwise regression. Practical problems are solved using both packaged computer regression routines and routines students learn to write themselves. No prior knowledge of computer programming required. Prerequisite: MSY 422.

MSY 438 SURVEY SAMPLING (4 Hrs.)
Basic course in principles of sampling for assessment of data in business, social sciences, or natural resource management. Sampling problem, selection of samples, designing questionnaire, estimation of means and variances, simple and stratified random sampling, systematic sampling, and cluster sampling.

MSY 439 NONPARAMETRIC STATISTICS (4 Hrs.)
Statistical methods that do not depend upon particular form of the density function of the underlying distribution. Includes selected distribution-free tests and estimation techniques including sign test. Kolmogorov-Smirnov, Wilcoxon signed rank. Mann-Whitney tests, Chi-square and rank correlation tests. Prerequisites: MSY 421 and MSY 422 or equivalent.

MATHEMATICS CONCENTRATION

MSY 400 TOPICS IN GEOMETRY **(1-4 Hrs.)**
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours.

MSY 407 FOUNDATION OF MATHEMATICS **(4 Hrs.)**
Discussion of the axiomatic system and infinite sets, and how they produced contradictions in mathematics in the late 19th century. Attempts to free mathematics from these contradictions and Godel's Theorem are described.

MSY 410 TOPICS IN ALGEBRA **(1-4 Hrs.)**
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours.

MSY 411 LINEAR ALGEBRA I **(2 Hrs.)**
Systems of linear equations, matrices, vector spaces in Euclidean n-space, linear dependence and independence.

MSY 412 LINEAR ALGEBRA II **(2 Hrs.)**
Abstract vector spaces, bases for finite dimensional spaces, linear transformations, similarity canonical forms, eigenvalues, quadratic and bilinear forms.

MSY 413 ABSTRACT ALGEBRA **(4 Hrs.)**
Theory of groups, rings, and fields. Subgroups, ideals, integral domains, quotient algebras, isomorphisms, and homomorphisms are covered. Prerequisite: MSY 412.

MSY 415 ADVANCED CALCULUS **(4 Hrs.)**
Introduction to basic theory of analysis including rigorous treatment of sequences, series, continuous functions, theory of differentiation, and Riemann integration. Prerequisite: one year of calculus.

MSY 417 NUMERICAL ANALYSIS **(4 Hrs.)**
Introduction to fundamental numerical algorithms; elementary error analysis; polynomial interpolation; solution of linear and nonlinear systems of equation; numerical solution of differential equations. Prerequisites: calculus; MSU 421 or MSY 411; MSU 414 or MSY 451; or equivalents.

MSY 418 METHODS OF APPLIED MATHEMATICS **(4 Hrs.)**
Various topics for science and mathematics students; may include ordinary and partial differential equations, fourier series, vector analysis. Emphasis is on application. Prerequisite: calculus.

MSY 419 DIFFERENTIAL EQUATIONS **(4 Hrs.)**
Initial value problems. Topics include existence and uniqueness of solutions, linear systems, and autonomous systems. Prerequisite: MSY 415 or equivalent.

MSY 420 TOPICS IN ANALYSIS **(1-4 Hrs.)**
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours. Prerequisite: MSY 415.

MSY 500 ADVANCED TOPICS IN GEOMETRY **(1-4 Hrs.)**
Various topics; description changes depending on topics offered. May be repeated for an indefinite number of hours.

MSY 507 SYMBOLIC LOGIC **(4 Hrs.)**
Formal treatment of the propositional and predicate calculi. Concepts of validity, implication, deductibility, consistency, and completeness. Student must be able to read and write proofs in abstract mathematics. Prerequisite: MSY 407 or equivalent.

SERVICE COURSES FOR NONMAJORS

MSU 401 APPLIED STATISTICS I (4 Hrs.)
For nonmath majors. Introduction to basic elements of probability and statistical theory. Topics may include analysis of data; finite sample spaces; probability distributions, statistical inference; testing of hypotheses; regression and correlation. Adequate background in high-school algebra required. Students may not take more than one of MSU 401, MSU 305, or MSU 405 for degree credit. See SOA 413.

MSU 402 APPLIED STATISTICS II (4 Hrs.)
Linear regression and correlation, analysis of enumerative data, test statistics, random sampling, design of experiments—block and Latin square designs, analysis of variance, certain nonparametric tests. Prerequisite: MSU 401. See SOA 414.

MSU 403 SO YOU THINK YOU CAN'T DO MATH! (4 Hrs.)
Attempt to reduce anxiety about mathematics. Brush-up on basic mathematical skills. Glimpses of history and present-day applications of mathematics.

MSU 405 A COMPUTER-ORIENTED APPROACH TO STATISTICS (4 Hrs.)
Introduction to statistics. Students with no prior knowledge in computer programming learn to use packaged statistical programs and to write their own programs as they learn about simulations, descriptive statistics, elementary matrix methods, inferential statistics, regression, and correlation. Students may not take more than one of MSU 401, MSU 305, or MSU 405 for degree credit. Prerequisite: high-school algebra.

MSU 406 SAMPLING FOR ACCOUNTING AND AUDITING (4 Hrs.)
For accounting and auditing students. Topics may include sampling principle, sampling plans, attribute and variable sampling, selection techniques, random number sampling, systematic and stratified sampling, sample size determination, and estimation procedures, simple extension, difference ratio and regression methods. Prerequisite: MSU 401 or equivalent.

MSU 407 QUANTITATIVE ANALYSIS (2 Hrs.)
Statistical and quantitative methods from the perspective of administrative decision-making. The logical basis of modern quantitative techniques and their application to health services administration problems. See HSA 407.

MSU 408 HEALTH RESEARCH ANALYSIS (2 Hrs.)
Quantitative techniques as applied to the health field. Includes regression and correlation, analysis of variance, and introduction to operations research. Prerequisite: HSA 407 or equivalent. See HSA 408.

MSU 409 TECHNIQUES OF ANALYSIS (2 Hrs.)
For nonmathematics majors. Techniques of differentiation and integration. Self-study modules on slides and tape in the Learning Center.

MSU 413 OPERATIONS RESEARCH FOR MANAGERIAL DECISIONS (4 Hrs.)
Introduction to methods of operations research and management science; applications to government, industry, education, and health. Prerequisite: high-school algebra.

MSU 414 INTRODUCTION TO COMPUTER PROGRAMMING I (2 Hrs.)
Introduction to computer programming for nonmath majors. Interactive use of Basic, an early learned language, is emphasized. Students may not take both MSU 414 and MSY 451 for credit.

MSU 415 INTRODUCTION TO COMPUTER PROGRAMMING II (2 Hrs.)
Continuation of MSU 414. Further techniques of programming and problem-solving. Students may not take both MSY 452 and MSU 415 for credit.

MSU 421 MATRICES: A MATHEMATICAL TOOL (2 Hrs.)
Primarily for nonmathematics majors. Understanding of quantitative tools used in studying many disciplines. Introduction to systems of linear equation, matrix manipulation, and determinants. Emphasis is on using these tools, rather than proving theorems. Prerequisite: high-school algebra.

MSU 423 COMPUTER FUNDAMENTALS FOR ADMINISTRATION (2 Hrs.)
Fundamentals of data processing and computer systems. Use of Basic programming language in business problem-solving. Applications of time-sharing.

MSU 431 MATH GAMES (2 Hrs.)
Introduction to the use of games to teach arithmetic. Mostly for primary and secondary teachers.

MSY 425	Statistical Inference	4 hours
OR/SA Practicum		10 hours
(MSY 470-6 hours and MSY 570-4 hours.)		
(Up to four hours of other OR course work substituted for students with project experience.)		

In addition, the student must pass the OR/SA Core Exams, display competency in reading OR/SA literature, and demonstrate the ability to lead an operations research study. A handbook providing detailed degree requirements is available from program faculty.

Quantitative Tool Subjects and OR/SA Core

Competence in the fundamentals of a variety of quantitative disciplines is necessary to obtain, analyze, and evaluate information for sound decision-making. Therefore, the OR/SA student is required to take the following courses unless the skills needed have been demonstrated by previous course work.

ACC 421	Administrative Uses of Accounting Information	4 hours
MSY 411	Linear Algebra I	2 hours
MSY 412	Linear Algebra II	2 hours
MSY 421	Probability and Statistical Applications	2 hours
MSY 422	Statistical Analysis	2 hours
MSU 414	Introduction to Computer Programming I	2 hours

To ensure breadth in the fields of operations research and systems analysis, the student is required to demonstrate mastery of the techniques of defining problems, constructing mathematical models, and deriving solutions via a series of six competency exams. A reading list is available for each exam. The student may prepare for these examinations by taking the following OR/SA Core courses:

MSY 472	Construction of Deterministic Operations Research Models	2 hours
MSY 473	Construction of Probabilistic Operations Research Models	2 hours
MSY 474	Solution of Deterministic Operations Research Models	2 hours
MSY 475	Solution of Probabilistic Operations Research Models	2 hours

The graduate student may matriculate after:

1. Earning a B or better in the first eight hours of MSY courses, four of which must be in OR; or earn a B average in the first 12 hours of MSY courses (four of which must be in OR) and earn B or better in the OR course. In either case all incompletes must be removed and their grades counted.
2. Passing the calculus examination.
3. Taking the communications skills diagnostic test.

The university requirement of a graduation project is normally satisfied by MSY 570 OR/SA Practicum.

OPERATIONS RESEARCH/SYSTEMS ANALYSIS CONCENTRATIONS

Operations Research/Systems Analysis (OR/SA) is concerned with applying quantitative techniques to problem-solving and decision-making. The program provides options of interest to students with nontechnical backgrounds as well as those with quantitative backgrounds. There are two master's degree options: the M.A. in public systems analysis and the M.A. in operations research. Basic to both is the OR/SA practicum during which students apply quantitative problem-solving techniques to the solution of real problems.

The M.A. in Public Systems Analysis

This program is designed to interest the student whose undergraduate specialty differed from the study of techniques of quantitative problem-solving. Although candidates need not have strong mathematics backgrounds, they must have the willingness to learn various types of applied mathematics necessary to use operations research and systems analysis techniques. Entering students are expected to have a bachelor's degree in a nonquantitative discipline. The program generally requires 40 semester hours of study; however, students may petition the mathematical systems program committee for up to 10 semester hours of advanced standing. The course requirements for this degree are:

MSU 409 Techniques of Analysis	2 hours
OR/SA Core courses	8 hours
400- or 500-level course work related to problems in the public sector	12 hours
OR/SA Practicum (MSY 470-6 hours and MSY 570-4 hours)	10 hours

(Up to four hours of other OR course work substituted for students with project experience.)

In addition, the student must pass the OR/SA Core Exams, display competency in the quantitative tool subjects described later, and demonstrate the ability to use operations research in the public sector.

The M.A. in Operations Research

This program is for the student with an undergraduate degree in science, engineering, or mathematics (including computer science, OR/SA, and statistics) who is interested in becoming an operations research analyst or systems analyst. The M.A. requires 40 semester hours of work, up to 10 hours of which may be waived for the student with a good background in operations research, statistics, or mathematics. (See quantitative tool or OR/SA Core courses described later.) Students concentrate on mathematical theory underlying techniques of operations research and systems analysis and develop skill in supervising an operations research study. The course requirements for this degree are:

Operations research (excluding OR/SA Core courses and OR/SA Practicum	12 hours
Mathematics (past calculus)	4 hours

STATISTICS CONCENTRATION

The entrance requirements for a student concentrating in statistics are:

1. Completing eight hours of the following 12 hours: MSY 411-412 Linear Algebra; MSY 425 Statistical Inference; MSY 415 Advanced Calculus.
2. Earning eight hours in graduate-level MSY courses with grades of B or better as a graduate student.
3. Passing the calculus examination.
4. Taking the communications skills diagnostic test.

An M.A. in statistics requires 40 semester hours. A total of 28 hours must be in statistics, at least 12 of which are at the 500 level. In addition, a student must also take four hours of mathematics from the following list:

MSY 415 Advanced Calculus
MSY 417 Numerical Analysis
MSY 519 Complex Analysis

If the student has not had advanced calculus as an undergraduate, the four hours must be in advanced calculus. The student who has not had linear algebra must take MSY 411 and MSY 412 Linear Algebra I and II as part of the electives. Up to 10 hours of the total 40 may be waived for the student who has taken probability and statistical applications, statistical analysis, statistical inference, and linear algebra as an undergraduate.

The general university requirement of a graduation project is satisfied by taking MSY 549. The student will be required to develop a written and oral report on some topic not previously studied in this course. The topic and presentation should demonstrate the student's ability to bring together theory from different fields of statistics.

COMPUTER SCIENCE CONCENTRATION

The student may enter the concentration after:

1. Demonstrating course background or competency in subject areas required of an undergraduate in computer science at SSU: i.e., MSY 451 Computer Fundamentals and Programming I; MSY 452 Computer Fundamentals and Programming II; MSY 453 Computer Architecture; MSY 454 Information Structures; MSY 455 Structure of Programming Languages; and MSY 461 Operating Systems Principles. These courses will not count toward hours required for the master's degree.
2. Completing eight hours of B or better work in graduate-level MSY courses beyond the courses listed in No. 1.
3. Passing the calculus examination.
4. Taking the communications skills diagnostic test.

The M.A. in computer science requires 30 semester hours, 24 hours of which must be in computer science or related mathematical systems courses.

The university requirement of a graduation project is satisfied by taking MSY 569 Individual Project.

10 Practical Significance and Mathematical Models in Administrative Research

James F. McNamara

An editorial inaugurating a new department in the *Educational Researcher*—"R&D in Progress in Schools"—by Richard Schutz was concerned with the difference between academic research on schools and operational research in schools.[1] According to Schutz the difference is in terms of context and communication, and not in terms of methodology or merit. Schutz notes further that context differences are rather apparent but that communication differences in the sense of availability and frequency of reporting mechanisms heavily favors research on schools. Conceding that research on schools and research in schools both can be conducted by either a school or extra-school agency, research in schools is typically an intraschool activity, and research on schools is characterized as an extra-school agency activity. Finally, Schutz points out that there is little value in transforming one kind of research into the other, although both are important to research-and-development progress in education.

Even though this analysis was initially derived for the larger educational research-and-development community, there are no compelling reasons to alter the description for operational and academic research activities in educational administration. Further, there is little question that both kinds of inquiry—academic and operational research—have potential for contributing to knowledge and theory development in educational administration. The value of academic and operational studies is of paramount import in this respect. How can the credibility of research and research findings be established? And, can the credibility of both academic and operational research be ascertained in the same way?

It is important to explore systematically the extent to which critical assessments of design and analysis shed light on the credibility of research in an area and the extent to which such assessment provides leads for knowledge production and synthesis or theory development. In this chapter I wish to demonstrate that an interest in critical appraisal of research designs and data analysis procedures should be viewed as a highly relevant research priority not only from the point of view of conducting research but also in terms of reporting research within the professional arena. It is unfortunately frequently the case that consumers of research in educational administration, and some researchers themselves, often view descriptions of research design and statistical methodology as less interesting than the discussion of final results.

SOURCE: Chapter 10 in Glen L. Immegart and William L. Boyd (eds.). Problem Finding in Educational Administration: Trends in Theory and Research. Lexington, Massachusetts: Lexington Books, 1979.

In light of Schutz's distinction between research *on* schools and research *in* schools, and the corresponding need to attend more accurately to the similarities and differences of these two inquiry orientations, this chapter is divided into two major parts. The first part will concentrate on academic research. Here one approach for conducting a critical appraisal of design and method will be illustrated. The appraisal will center on a single research issue, the distinction between statistical and practical significance. In the second part, the concern will be with operational inquiries.[2] Since there is a dearth of reporting of these kinds of studies in the educational administration literature, and since there is no available precise assessment procedure (such as practical significance with academic studies), the design and analysis considerations that should guide operational research will be identified first. Then an actual operational research effort, one also illustrating a mathematical modeling approach, will be discussed and analyzed. The chapter will close with an overview of selected contemporary research issues that appear to have been given relatively low priority in some professional sectors.

Statistical and Practical Significance[3]

Two kinds of statistical tests of particular interest to researchers are those that test for the significance of relationships and those that test for the significance of differences.[4] To determine whether there are significant differences among two or more groups, researchers frequently employ a single classification analysis of variance. This set of statistical decision rules allows one to specify directly the statistical significance associated with the test of an experimental hypothesis of interest. Practical significance, on the other hand, depends on an accurate estimate of the strength of a statistical association. The practical significance assessment usually follows the design employed in tests for the significance of relationships, and often begins by asking, "How much of the variance in a criterion measure can be accounted for by a prediction measure?"

Both statistical and practical significance use the information reported for an *F* test. This can be illustrated using the analysis of variance (ANOVA) results reported in a study by Shetty and Carlisle, which attempted to analyze faculty perceptions regarding the success of a management by objectives (MBO) program implemented in a major land grant university.[5]

Independent Variables in the ANOVA Design

A total of 109 professors was grouped according to three professorial characteristics: professorial rank, tenure status, and length of service in the university. The number of groups for each of these three independent variables is given in table 10-1. Hence it can be observed that tenure status has two groups. Moreover, 62 of the 109 professors participating in the study were tenured, whereas the remaining 47 participants were not.

Criterion Variable in the ANOVA Design

To formulate a single criterion variable Shetty and Carlisle first solicited faculty perceptions regarding the success of the MBO program on ten dimensions of interest. These ten responses were then averaged to provide a single indicator for each of the 109 faculty members.

To examine the relationships between various faculty characteristics and perceived success of the MBO program, three ANOVA tests were developed using the null hypothesis of no difference among means. For all three tests, statistically significant differences were reported. These results are also shown in table 10-1. Following an obvious trend for most statistical studies reported in the *Educational Administration Quarterly*, the authors' decision to reject the null hypotheses terminated the formal statistical analysis, and they proceeded to describe what they believed to be the relationship between perceived program success and each faculty characteristic.

Table 10-1
Relationship between Faculty Type and Success of MBO Program

Faculty Type	*N*	*Mean Scores*	*Standard Deviation*	*F Ratio*
Professorial rank				
Professor	24	3.051	.497	7.97
Associate professor	29	3.181	.532	(df = 3,105)
Assistant professor	41	3.542	.592	($p < 0.001$)
Instructor	15	2.864	.386	
Tenure				
Tenured	62	3.160	.500	3.07
Nontenured	47	3.356	.665	(df = 1,107) ($p < 0.10$)
Length of service				
1-3 years	32	3.416	.607	4.59
4-7 years	34	3.335	.537	(df = 2,106)
7 years or more	43	3.045	.552	($p < 0.02$)

Source: Y.K. Shetty and H.M. Carlisle, "Application of Management by Objectives in a University Setting," *Educational Administration Quarterly* 10, no. 2 (Spring 1974). Their corrected table appears in vol. 10, no. 3 (Autumn 1974). Reprinted with permission.

ANOVA Designs: Rejection of the hypotheses of no differences between population means is tantamount to the assertion that the independent variables do have some statistical association with the criterion scores. However, the occurrences of statistically significant differences say nothing at all about the strength of the association between independent variables and the criterion of interest, and in no sense can one infer from only these results that important degrees of association necessarily exist.

If the formal statistical analysis in the Shetty and Carlisle study had not been terminated immediately following the rejection of the hypotheses of no differences, they might have used the ANOVA results of table 10-1 to formulate several questions that influence the relationship between practical and statistical significance. Consider just the following:

1. How does one relate the F ratio of 7.97 obtained for the analysis of professorial rank with the F ratio of 3.07 for the tenure data?

2. Does the larger F test value of 7.97 necessarily imply that a more important degree of association exists between the independent variable of professorial rank and the criterion variable indicating the perceived success of the MBO program?

3. How significant is the level of significance at which the null hypotheses were rejected for these variables? (How much more significant is the test value for professorial rank, $p < 0.001$, as compared to the test value of $p < 0.02$ for length of service?)

There are several statistical techniques that can be used to evaluate practical significance concerns such as those suggested in these three questions.[6] Assuming that Shetty and Carlisle were investigating a defensible criterion variable, their analysis might begin by suggesting that each of the three independent variables is practically significant to the degree that it accounts for the variance of the dependent variable. If one of their independent variables accounts for all the variance in criterion scores, it affords a perfect basis for the prediction of the criterion variable. If one of their independent variables accounts for none of the variance of the dependent variable, it has no utility in predicting the dependent variable.

Index Values for Practical Significance

One of the most frequently applied statistical techniques for estimating the proportion of the variance of the dependent variable (Y) accounted for by a given independent variable (X) is a statistical index called ω^2 (Greek omega, squared). Viewed either as a proportion of variance in Y accounted for by X or as a relative reduction of uncertainty, this index, ω^2, can assume values ranging from zero to unity, and is similar to two other indices, the intraclass correlation and the correlation ratio. When ω^2 is 1.0, the independent variable correlates exactly with the dependent variable. On the other hand, when ω^2 is zero, the knowledge of the independent variable does not reduce in any way uncertainty about the dependent variable. In general, the higher the value of ω^2, the greater the practical significance for the association of X and Y.

For a univariate analysis of variance with one independent variable,

$$\text{est. } \omega^2 = \frac{SS(B) - (k-1) \cdot MS(W)}{SS(T) + MS(W)} \qquad (10.1)$$

where $SS(B)$ = sum of squares between groups

$SS(T)$ = sum of squares total

$MS(W)$ = mean square within groups

k = number of levels of the independent variable

This formula allows direct estimation of ω^2 from the summary table of ANOVA results. In the case where a complete summary table of ANOVA results is not presented, it is usually possible to construct the needed information from available data.

Constructing ANOVA Tables: It is not uncommon for tables of results to show only sample size, means, standard deviations, and F ratios. A review of table 10-1 information on the Shetty and Carlisle study provides an excellent example of this form of reporting. When at least this amount of information is provided, the ω^2 estimate can be derived using the following method. Let $i = 1, 2, \ldots, k$ represent each group. By definition:

$$\bar{X} = \Sigma[N(i) \cdot \bar{X}(i)]/N \qquad (10.2)$$

$$SS(B) = \Sigma[N(i) \cdot [\bar{X}(i) - \bar{X}]^2] \qquad (10.3)$$

$$SS(W) = \Sigma[\Sigma x^2(i)] \qquad (10.4)$$

where $\Sigma x^2(i) = [N(i) - 1] \cdot S^2(i)$

$$MS(B) = SS(B)/(k-1) \quad (10.5)$$

$$MS(W) = SS(W)/(N-k) \quad (10.6)$$

$$SS(T) = SS(B) + SS(W) \quad (10.7)$$

$$F = MS(B)/MS(W) \quad (10.8)$$

and where $\bar{X}(i)$ = mean of observations in group i (group mean)

$\bar{X}$ = mean of all N observations (grand mean)

N = number of observations in ANOVA design

$N(i)$ = number of observations in group i

$\Sigma x^2(i)$ = the sum of squared deviations for all observations in group i

$S(i)$ = the standard deviation for all observations in group i

$MS(B)$ = mean square between groups

and other terms are defined as given in equation 10.1.

For example, if one wished to estimate ω^2 for the F test associated with length of service, substitution of information from table 10-1 produces

$$\bar{X} = \frac{32(3.42) + 34(3.34) + 43(3.05)}{32 + 34 + 43} = 3.25 \quad (10.2a)$$

Continuing,

$$SS(B) = 32(0.17)^2 + 34(0.08)^2 + 43(0.20)^2 = 2.86 \quad (10.3a)$$

$$SS(W) = 31(0.61)^2 + 33(0.54)^2 + 42(0.55)^2 = 33.86 \quad (10.4a)$$

$$MS(B) = 2.86/2 = 1.43 \quad (10.5a)$$

$$MS(W) = 33.86/106 = 0.32 \quad (10.6a)$$

$$SS(T) = 33.86 + 2.86 = 36.72 \quad (10.7a)$$

$$F = 1.43/0.32 = 4.50 \quad (10.8a)$$

The obtained F value of 4.50 compares closely with the F value of 4.59 shown in table 10-1. Applying equation 10.1 with this ANOVA information yields:

$$\text{est. } \omega^2 = \frac{2.86 - (2)(0.32)}{36.72 + 0.32} = .0599 \quad (10.1a)$$

In something less than lay parlance, this figure says that the independent variable, length of service, accounts for about 6 percent of the criterion variance. If these calculations were repeated for the independent variable of professorial rank, the estimated ω^2 value would be 0.1611, which suggests that approximately 16 percent of the variation in the criterion scores can be accounted for by the independent variable, professorial rank.

An Alternate Formula: The amount and type of information represented in table 10-1 are not, however, always reported. Summary tables in any form are often replaced in organization inquiries with only a report of F values and the appropriate degrees of freedom for the test [for example, $F(2,106, 4.59, p < 0.02)$], making the previous derivation of values seem only an entertaining intellectual exercise. Even for these cases, however, ω^2 can still be estimated directly using an alternative form of the basic formula.

In a single classification ANOVA we have

$$F = MS(B)/MS(W), \tag{10.9}$$

which can also be written

$$F = \frac{SS(B)/df(1)}{SS(W)/df(2)} \tag{10.10}$$

where $df(1)$ equals $(k-1)$, $df(2)$ equals $(N-k)$, and N is the total number of observations in the test. Solving 10.10 yields

$$SS(B) = F \cdot (k-1) \cdot MS(W) \tag{10.11}$$

By definition

$$SS(W) = (N-k) \cdot MS(W) \tag{10.12}$$

$$SS(T) = SS(B) + SS(W) \tag{10.13}$$

Using equations 10.11 and 10.12, equation 10.13 can be rewritten as:

$$SS(T) = F \cdot (k-1) \cdot MS(W) + (N-k) \cdot MS(W) \tag{10.14}$$

Substituting for $SS(B)$, $SS(T)$, and $MS(W)$ in 10.1 produces

$$\text{est. } \omega^2 = \frac{F \cdot (k-1) \cdot MS(W) - (k-1) \cdot MS(W)}{F \cdot (k-1) \cdot MS(W) + (N-k) \cdot MS(W) + MS(W)} \tag{10.15}$$

Factoring out $MS(W)$ from 10.15 yields

$$\text{est. } \omega^2 = \frac{F \cdot (k-1) - (k-1)}{F \cdot (k-1) + (N-k) + 1} \tag{10.16}$$

Where F is the numerical value for the ANOVA test, N is the total number of individuals in the sample, and k is defined as in equation 10.1.

For the case $F(2,106, 4.59, p < 0.02)$—which happens to be the information for the length of service variable in table 10-1—this formula produces

$$\text{est. } \omega^2 = \frac{(3-1)(4.59) - (3-1)}{(3-1)(4.59) + (109-3) + 1} = 0.0618 \tag{10.16a}$$

Allowing for round-off error, it can be seen that this value for ω^2 is the same estimate that was derived by using equation 10.1. For the professorial rank data with $F(3,105, 7.97, p < 0.001)$, the formula yields

$$\text{est. } \omega^2 = \frac{(4-1)(7.97) - (4-1)}{(4.1)(7.97) + (109-4) + 1} = 0.1611, \tag{10.16b}$$

which again corresponds to the estimates found when equation 10.1 was applied.

t-test: In the special case where $K = 2$, single classification ANOVA results are often expressed in terms of a pooled variance *t*-test value rather than an *F* ratio. In this case $t^2 = F$, and either 10.16 or the more familiar formula found in most elementary research and evaluation texts can be used. It is:

$$\text{est. } \omega^2 = \frac{t^2 - 1}{t^2 + N(1) + N(2) - 1} \tag{10.17}$$

Since $N(1) + N(2) = N$ and $t^2 = F$, the equivalence of 10.16 and 10.17 for a single classification ANOVA can be seen in the substitution given below. Substituting $k = 2$ in 10.16, we get

$$\text{est. } \omega^2 = \frac{(2-1)F - (2-1)}{(2-1)F + (N-2) + 1} = \frac{t^2 - 1}{t^2 + N - 1} \tag{10.18}$$

Using the tenure variable case with $F(1,107, 3.07, p < 0.10)$, the equivalence of 10.16 and 10.17 can be illustrated as follows:

$$\text{est. } \omega^2 = \frac{(2-1)(3.07) - (2-1)}{(2-1)(3.07) + (109-2) + 1} = \frac{3.07 - 1}{3.07 + 62 + 47 - 1} = 0.0186$$

The Advantage of the Alternate Formula: The advantage of 10.16 is that it is applicable in all cases and does not require the reconstruction of a complete ANOVA table. The reduced time and effort also means fewer opportunities for miscalculations.

A Reassessment of the Data

How does the addition of information regarding practical significance affect the interpretation of results? The answer to this question can be illustrated using any of the variables from table 10-1. For instance, the relationship between tenure status and the dependent variable is viewed as significant statistically ($p < 0.10$). However, the estimated ω^2 value of 0.0186 suggests that approximately 2 percent of the variation in the criterion of interest is associated with variation in the independent variable.

An alternative, but consistent, way to interpret these results is to view ω^2 as a measure of the relationship between being a member of a particular group (tenured or nontenured) and having a particular level of perceived success. For this interpretation, the ω^2 value of 0.0186 indicates that a knowledge of group membership tells us virtually nothing about expected level of perceived success. Thus, despite the findings of statistical significance, the conclusion of no important degree of association or practical significance would appear justified.

An immediate advantage of ω^2 is that it provides a more accurate representation of association between variables in the Shetty and Carlisle study than does the magnitude of the *F* ratios reported in table 10-1. This increased differentiation of statistical tests results (which formerly could be considered homogeneous only in the sense that they were all "significant") communicates a great deal more information about experimental test results.[7] This advantage can be illustrated by returning to the three questions raised earlier:

1. How does one relate the *F* ratio of 7.97 obtained for the analysis of professorial rank with the *F* ratio of 3.07 for the tenure data?

2. Does the larger *F* test value of 7.97 necessarily imply that a more important degree of association exists between the independent variable of professorial rank and the criterion variable indicating the perceived success of the MBO program?

In answer to both questions, although the F ratio for professorial rank is approximately 2.6 times that associated with the tenure data, this ratio is misleading and inappropriate for direct comparisons. The presence of different numbers of degrees of freedom rules out the comparison of one F ratio with another.

3. How "significant" is the level of significance at which the null hypotheses were rejected for these variables? (How much more significant is the test value for professorial rank, $p < 0.001$, as compared to the test value of $p < 0.02$ for length of service?)

Regarding probability levels associated with the F tests, is the F ratio for professorial rank, $p < 0.001$, twenty times more significant than the F ratio for length of service, $p < 0.02$? That is, is the independent variable of professorial rank twenty times more effective in predicting the same criterion variable? Again, although a fair-sized body of folklore would suggest that such is the case, this is also an inappropriate comparison on which to base interpretations.

The Educational Administration Quarterly Analysis

Since the statistical analyses of several studies published over the past twelve years in the *Educational Administration Quarterly* (*EAQ*) follow the path taken by Shetty and Carlisle, it should be of interest to describe briefly this sequence of events.

Richard Schutz characterized the path in this manner:

> The logic in making the test of the null hypothesis is as follows. If the obtained F ratio exceeds the tabled ratio, the experimenter rejects the null hypothesis and infers that the independent variable did indeed have an effect. If the obtained F value does not exceed the tabled value; the experimenter fails to reject the null hypothesis; since the effects of the independent variable do not exceed those which could be expected to occur by chance 95 or 99 times out of 100, he infers that the independent variable had no effect. One's decision concerning the rejection of the null hypothesis customarily terminates the formal statistical analysis. That is, one finishes the "results" section and enters the "discussion." If the obtained F or t ratio is "significant," there is something to discuss. If the ratio doesn't "achieve significance," one is very disappointed, and it is doubtful that the report of the research will ever be published.
>
> The subordination of error variance to an incidental role and the concomitant elevation of final test of the hypothesis has had an unfortunate effect on the behavior of educational researchers. Despite the lip service that has been devoted to the distinction between statistical significance and practical significance, our statistical procedures have simply not mediated any systematic method of handling practical significance.[8]

To provide some indication of how ω^2 can be used to illustrate the consequences of basing the interpretation of data entirely on significance testing, each article in the first twelve volumes of the *EAQ* that reported an ANOVA or t test was examined. For each test that resulted in a rejection of the null hypothesis of no difference, the ω^2 was calculated as a means to measure the practical significance associated with these rejection decisions.[9] A tabulation of these calculations appears in table 10-2.

If this analysis reflects a more general trend for academic research either conducted in or endorsed by educational administration, the results are discouraging. This experience was informative, however; it did reveal some general characteristics for studies that have appeared in *EAQ* over the past years. These include:

Table 10-2
Practical Significance Tests for Findings Reported in the *Educational Administration Quarterly*

Omega Squared Ranges	*Volumes of the EAQ*				*Percent (1-12)*
	(1-6)	*(7-11)*	*(12)*	*(1-12)*	
.0001 .0099	52	8	16	76	26.39
.0100 .0199	15	7	26	48	16.67
.0200 .0299	4	6	14	24	8.33
.0300 .0399	3	9	4	16	5.56
.0400 .0499	2	9	6	17	5.90
.0500 .0599	4	1	1	6	2.08
.0600 .0699	1	5		6	2.08
.0700 .0799	1	6	3	10	3.47
.0800 .0899	4	6	4	14	4.86
.0900 .0999	1	1	3	5	1.74
.1000 .1999	5	15	20	40	13.89
.2000 .2999	1	12	3	16	5.56
.3000 .3999	2	1	1	4	1.38
.4000 .4999	1	2		3	1.04
.5000 .5999	1			1	0.35
.6000 .6999	1			1	0.35
.7000 .7999		1		1	0.35
Number of tests	98	89	101	288	100.00
(Number of studies	7	14	10	31)	

1. Only one of the thirty-one articles using either t or F tests reported ω^2 values. No other statistical method of estimating variance percentages was applied in the thirty-one articles.

2. Three additional articles failed to report t or F information necessary to calculate ω^2. In all three cases this included a failure to specify the degrees of freedom associated with the test. Hence, it is not possible to estimate directly the extent to which the independent variables in these three studies accounted for variance in the corresponding dependent variables.

3. At least 60 percent of the formal statistical analyses followed almost to the letter the sequence of events characterized by Schutz.

4. An interest in replicating previously published *EAQ* studies was not detected.

5. A rationale for decisions regarding the selection of an appropriate sampling procedure and the determination of sample size, as well as a specification of how the investigator dealt with nonsampling errors such as nonresponse bias, were noticeably absent in a majority of the thirty-one articles.

6. Also noticeably absent from the explanations of statistical analyses were any informative comments on the power of specific F tests—that is, an integrated treatment of the consequences associated with both Type I and Type II errors.

7. In some ANOVA studies the same independent variable is used to assess significant differences for fifteen or more distinct criterion variables, without any reference to the possibility that one or more of the resulting individual F test differences might be due merely to chance since the set of F tests is not statistically independent. For example, if one uses the same independent variable for testing at the .05 alpha level significant differences associated with ten distinct criterion variables, the probability of finding at least one significant difference (among the set of ten independent tests) that is due to chance alone is $1-(1-0.05)^{10}$, or approximately 37 percent. (The situation with respect to dependent tests is even worse in this regard.)

8. In some cases, a series of n single classification, univariate ANOVA tests should have been replaced by a single n-way univariate design that provides explicit opportunities to explore interactions as well as main effects.[10]

9. Opportunities to use multivariate ANOVA designs or other multivariate statistical methods were also bypassed.

The distributions presented in table 10-2 lead to the following general comments:

1. The number of studies using ANOVA designs appears to be increasing over time. Twenty-four of the thirty-one studies applying these designs were published in the second 6 volumes.

2. Approximately one-third of the statistically significant test results, as well as one-third of the studies using ANOVA designs, appeared in volume 12 alone.

3. In volume 12 approximately 56 percent of the statistically significant differences had a ω^2 of less than 0.03. Thus, despite the findings of statistical significance, the conclusion of no important degree of association or practical significance would appear justified in almost all of the fifty-six cases.

4. If it is correct to assume that each study was investigating defensible criterion variables, and we link this assumption with the fact that, over the past twelve years, 63 percent of the statistically significant results reported in the *EAQ* have a ω^2 value of less than 0.05, it is entirely possible that several of the already published discussion sections in these thirty-one articles should be rewritten or at least viewed with caution.[11]

Classifying Practical Significance Results

If a consensus could be reached that the relationship between an independent and dependent variable would have a practical significance only when ω^2 was at least 0.10, then volume 12 would yield twenty-four practically significant results and seventy-seven results that did not meet this criterion.

If the consensus value for deserving a high rather than low practical significance status required ω^2 to be greater than 0.20, then all issues of volume 12 would have four high (and ninety-seven low) practically significant test results. If it were agreed to set the cut-off value at ω^2 greater than 0.299, then only 1 of the 101 results reported in table 10-2 would meet practical significance status.

This hypothetical classification illustration leads to two questions. First, what is an appropriate ω^2 value for the test of an experimental hypothesis to yield a practically significant result? In most educational research studies the use of practical significance indices are rare. In one national-based *EAQ* study, however, the author imposed an ω^2 requirement of at least 0.10 for practical significance.[12] In that study all statistically significant tests failed to reach the established criterion limit. Accordingly, the researcher's report attributed the statistically significant differences to sample size rather than to any actual strong association between variables. In general, it is safe to say that the required ω^2 value for practical significance probably is best determined by the nature of the study and the variables involved.[13] However, ω^2 values should still be reported, and authors should inform their readers as to their position on ω^2 requirements for practical significance associated with each hypothesis tested in a study.

Second, how often do readers mistakenly assess the significance of studies based on results given in *EAQ*? This question has no direct answer. There is no way of determining how often the *EAQ* is consulted or cited as a reference for various decision situations encountered either in field settings or in theory development and the design of research studies. Although some researchers might argue that research findings presented in the *EAQ* are almost never used to reach critical decisions in actual organizational settings, the fact still remains that we do not have adequate direct means for estimating how often administrators on state, local, and national levels make use of *EAQ* findings. This is true particularly when a discussion section provides an opportunity to duplicate and circulate research conclusions that support an administrator's viewpoint or preferred alternative.[14]

Theory development and research studies almost always involve the preparation of a review of related research. Here again, there is no readily available direct evidence on the extent to which theorists and researchers use the findings of *EAQ* studies in their work. Moreover, when they do include *EAQ* studies, it is difficult to gauge accurately the extent to which they attempt to relate statistical and practical significance as a means to improve their critical assessments of prior research findings. Hence, it is possible not only that *EAQ* articles might be used extensively in current reviews of research, but also that this use is largely restricted to merely referencing or counting the number of statistically significant differences on criterion variables of interest.

Implications and Future Directions

Most researchers agree that ω^2 communicates a good deal more information than the traditional F value. It provides a measure of the strength of an effect regardless of sample size and, thus, provides a more accurate representation of the degree of prediction. Moreover, since ω^2 is calculated directly from ANOVA results, it creates no difficulty for the investigator.

With this in mind, ω^2 should be reported in professional journal articles, reviews of research, technical reports, and dissertations. Also, ω^2 values should be in the forefront when any researcher finishes the results section of his or her study and enters the section on discussion of significant findings.

Whereas the foregoing treatment of practical significance has centered almost exclusively on the application of ω^2 as a means to determine the importance and magnitude of differences identified in standard statistical tests of significance, the purpose of this analysis is not to imply that this index represents a statistical procedure just recently entered in the educational research literature. In fact, the ω^2 was used by Schutz in 1966 to assess the practical significance of research findings reported in educational research journals. However, the analysis does illustrate that in 1978—twelve years later—this rather straightforward and uncomplicated approach (or its equivalent) still has not found its way into the research literature published in the *EAQ*. Moreover, it is safe to say that the value of ω^2 analysis has been frequently overlooked in recent issues of other educational journals.[13]

Professors who train future researchers might initiate one or more of the following activities to demonstrate that ω^2 values communicate a good deal more information, and thus provide educational researchers with more accurate measures of the relative reduction of uncertainty that can be directly linked with particular studies.

In seminars devoted to research design, an interesting project might be to conduct a practical significance (ω^2) analysis on all recently completed doctoral dissertations. When classification errors (low ω^2 values for highly significant difference tests) are encountered, students could be asked to prepare revised interpretations and discussions of dissertation results. Comparisons of original and revised versions provide excellent means to illustrate the consequences of viewing tests of significance as the ultimate objective.

In seminars devoted to theory development or knowledge synthesis, professors should encourage students to compute and include ω^2 values (or their equivalent) for each research study reviewed. In the past, probability values (for example, $p < 0.01$) have generally been used to support theories. The intent there would be to suggest that ω^2 values rather than probability values should be used to indicate the satisfaction students have with elements of their theoretical framework.

If professors are able to locate current operational studies where the probability values associated with mean difference ANOVA tests were highly significant but the ω^2 values were extremely low, they might use a seminar group to conduct an organizational analysis (case study) to determine how administrators and other policy-making groups in the organization actually used

the results of significant-differences tests in subsequent decisions (that is, reporting results to the public, creating new priority issues, preparing press releases, changing teacher assignments, or implementing new instructional designs). Analysis of an actual organizational example and the real consequences that are uncovered in that setting may be far more convincing to graduate students, whose immediate professional interests center primarily on practice rather than theory development and verification.

All three of these suggested alternatives are designed to give students, as well as professors, the confidence to note the following. When highly significant ANOVA test results are accompanied by extremely low ω^2 values, one would do well to follow the advice of McNeil and his colleagues who interpret this situation as "knowing something for sure about very little."[16]

Mathematical Models in Operational Research

Since operational research findings are not reported in the educational administration literature, it is not feasible to conduct an extensive appraisal of the value of existing operational inquiries. Further, statistical approaches are not available for assessing the credibility of findings and analyses in these studies generally, as is the case with academic inquiries. This is indeed unfortunate, since a comparative approach with both kinds of research would contribute valuable insights on the differences and similarities of these two research orientations within the profession. However, it is important to maintain an interest in the validity of operational inquiries in terms of both design and the interpretation of research findings. The position taken here is that criteria for demonstrating the value of research results are ultimately intuitive, cannot be derived from some meta criterion, should include but extend well beyond the variance issue referenced in the earlier discussion of ω^2, are likely to change when the context and reporting requirements are altered, and, more important, cannot be separated from concerns to improve methodology used in either operational or academic research.

Operational research is expected to provide reliable and valid information that is useful to teachers, administrators, board members, and clients of the school. This necessitates a variety of considerations not ordinarily directly relevant in academic research. Moreover, the context in which operational research is conducted requires special attention to the goodness-of-fit between methodological techniques and evaluation problems.

Any attempt to accurately describe the similarities and differences between operational and academic research orientations requires one to explicitly address this goodness-of-fit issue, especially as it applies to the development of relevant mathematical models. Accordingly, I will identify several research considerations that should affect directly the construction of operational research models, and then I will briefly describe an actual operational research effort that illustrates how one might use a mathematical-modeling approach in a public school district resource allocation study will be provided.

Model Construction

Research problems encountered in constructing mathematical models are no different from those encountered in developing other types of operational research projects. Bernstein identifies the following:

> While all procedures need to fit the demands of the research problem, in evaluation research certain aspects become particularly problematic for purposes of design and data analysis. These include (1) specification of the research question(s) to be addressed; (2) selection of the appropriate population to test the hypotheses; (3) selection, assignment, and maintenance of subjects in treatment categories; (4) designation of a system that provides for early estimates of immediate program effects; later, more conclusive estimates of intermediate effects; and estimates of long-range effects; and (5) selection of data sources and/or analytic procedures that can serve as correctives for defective design strategies arising from constraints on the research.[17]

The specification of research questions can be contrasted as follows. In academic research, the researcher frequently begins with one or more criterion variables and hypothesizes about factors that would predict these variables. To deduce hypothesized relationships, one usually examines theoretical statements about the phenomenon of interest. In operational research, the procedure is often reversed. A researcher begins with an independent variable such as a program, a set of actual teaching strategies, or a particular intervention, and to assess how the independent variable affects a set of more or less vaguely identified goals.

This reversal presents a variety of demands. For example, the researcher often needs to learn from persons administering the actual program what the specific goals are. It is also necessary to specify the level of changes in the goal measures that will be relevant apart from whether such changes are statistically significant. It is further necessary to identify the important program of intervention inputs, to assess the degree to which persons administering the program or intervention agree with that definition of inputs, and to assess the degree to which the program of intervention is implemented in the actual environment in accordance with the definitions.

Once a researcher has satisfactorily specified the research questions and identified both criterion and independent variables, the next task is to select the appropriate study population and corresponding sample. In academic research, the sample is normally defined according to its appropriateness for testing hypothesized relationships. In operational research, the sample (population) has already been defined by virtue of its relationship to the program or intervention being evaluated. Hence, the task is not to determine an appropriate sample, but rather to determine how the available sample can be used and dealt with analytically.

Critical in this sense with operational inquiries are problems such as student attrition and attendance in inner city schools. Researchers also often encounter design problems associated with teacher turnover and multiple treatment effects when students are participating in several programs or interventions. The implication here is the following: In the initial stages of planning a research design for an operational inquiry, the need is not only to assess where the available sample violates necessary assumptions (for example, equivalent rates of attrition and student attendance patterns), but also to construct analytic procedures that provide some correction for defects resulting from the use of a less than optimal design. When the design is specified in the form of a mathematical model, corrective measures such as poststratification (from sampling theory) and alternative forms of covariance analysis are frequently applied.

Resource Allocation: An Arena for Operational Inquiries

Since the release of the Equality of Educational Opportunity Survey in 1966, an increasing number of studies have been conducted on factors affecting the learning of children.[18] This includes the efforts of economists, who have attempted to estimate the changes in different learning outcomes that can be

linked with changes in the level of specific school resources and inputs. In this type of resource allocation study, multiple linear regression techniques are the most commonly used functional form to estimate the relationships between outcomes and inputs. The largest number of these studies are based on available samples and do not permit random assignment of students to appropriate treatments to control for other factors that affect achievement.[19]

Efforts to reduce the threats to validity and to improve the methods of public school resource allocation studies have led to the following design considerations identified by Richard Murnane: using the individual child as the unit of observation, using longitudinal information on school inputs (including detailed information on each child's teachers), controlling for prior achievement, estimating different structures or models for different categories of children, including as many outputs of the schooling process as is possible, and separating peer group influences from those of the child's own background.[20]

It is extremely difficult for any single research project to satisfy all these conditions. This is especially true in conducting urban school district resource allocation studies, where outcome measures are seldom available in a convenient form linking individual student progress data over several academic years with relevant classroom variables, peer effects, teacher characteristics, treatment conditions, and background variables.

An Example: A recent study that illustrates the use of mathematical-modeling in operational research is one conducted by Murnane.[21] He examined the impact that school resources have on the cognitive achievement of black inner city children in elementary schools in New Haven, Connecticut.

Based on the application of multiple linear regression, his analysis was directed toward two general resource allocation concerns. The first part of the analysis initially examined the effect of the classroom as a whole on the achievement of children. Then the effects of specific classroom-related variables were considered. The second part of the analysis examined the relationships between characteristics of teachers and their effectiveness in teaching certain subjects or certain types of children.

The identification of variables included in the analysis, and the specification of the relationships among these variables, were summarized in thirty hypotheses.[22] The hypotheses were developed to represent the effects of school resources on learning outcomes and to reflect a more direct emphasis on important administrative decisions such as the hiring and placing of teachers and the determining of which children shall be classmates.

For analytic purposes, three samples were developed from available data on two cohorts of students. Cohort one, a third-grade group, was studied for a single academic year. Cohort two was examined for the period they were in second grade and third grade. The measures of cognitive achievement were standard scores on Metropolitan Achievement tests in reading and mathematics.

Murnane used three regressions. The three models and the logic for each can be summarized as follows. In the first model, year-end achievement was dependent on prior achievement, background characteristics, and school attendance. The assumption of this model was that the effect of a year of schooling was independent of the school and classroom environments. In the second model, year-end achievement was dependent on the child's classroom and the variables in the first model. This model's assumption was that the classroom environment was critical to the effect of a year of schooling. In the third model, year-end achievement was dependent on the school the child attended and the variables in the other two models. (The second model is, therefore, more disaggregated than the third. If there were no differences among classrooms, however, the second model collapses into the third model.) The assumption of the third model was that the school environment was critical to the effect of a year of schooling.[23]

The first of Murnane's hypotheses was the general hypothesis of the study.[24] It explored this question: If one wants to predict a child's achievement

at the end of a school year, and one already knows the child's achievement at the beginning of the school year and certain characteristics of the child's background, is it also important to know to which classroom the child is assigned for the school year? The second and third hypotheses were included to investigate the breakdown of differences among classrooms into intraschool and interschool differences. Essentially the second and third hypotheses allowed for the testing of the second and third models.

For all three samples in the Murnane study, the first hypothesis was rejected at the 0.01 significance level for mathematics. The second and third hypotheses were rejected at the 0.05 level for all cases.[25] These findings give strong support to the hypothesis that significant quality differences among classroom environments do exist. Moreover, the results of this study suggest that the differences among classrooms consist of both differences within the schools and differences among schools. The interested reader is encouraged to examine the research report in more detail.

It should be noted that the Murnane investigation exhibited the following desirable characteristics from among those identified earlier: the individual child was the unit of observation, longitudinal information on reading and mathematics was employed, detailed information on individual classrooms was matched with student data, interviews were used to frame hypotheses, and three samples of students were analyzed. Hence, there was an attempt to use available district records to examine the replicability of research results.

Implications: The substantive results of the Murnane study are probably of principal interest to decision-makers or those who allocate resources within the New Haven schools. One reason this might be the case is the fact that school district studies analyze data regarding the *effectiveness of a particular program of intervention in a particular setting*. Given the unique characteristics of a district's approach to instruction, its instructional environment may not match that found in any other district.

However, the report does provide public school administrators with an excellent example of how fact-finding and exploratory analysis in a single district might be structured, using mathematical-modeling and a regression framework to integrate and relate several sources of information likely to rest in different school ledgers, periodic reports, or separate computerized information files. If this general approach to analysis has the possibility of adding a new dimension to current administrative inquiries, then we will most likely need to reexamine ways existing school district record and reporting systems can be modified, since most of the information for these regression studies still require extensive manual data collection efforts. This appears to follow even in school districts currently maintaining elaborate computerized information systems.

On this point Hanushek makes the following observations based on a study of a relatively large urban school system in California:

> Major school systems across the country routinely collect and store enormous amounts of data about the educational process, but these data are seldom processed in a way that is helpful to decision making in the school systems. The central lesson to be learned from the single system analysis . . . was how existing data collected by most school systems could be tabulated to provide an evaluation tool to decision makers. The heavy investment by local schools in data processing equipment and management information systems has largely been directed at improving accounting within schools; too little effort has been directed at improving decision making about the educational process itself. Without excessive effort, local school systems could develop supplemental evaluation information to aid in hiring teachers and deciding among programs.[26]

In his analysis of research-and-development in progress in schools, Richard Schutz noted that operational research is typically an intraschool agency initiative, whereas academic research is usually an extraschool agency initiative. The Murnane report represents one exception to that tendency in operational research.

Future Directions

The differences between research *on* schools and research *in* schools represent an essential consideration in assessing what factors affect the quality of research and in evaluating individual studies. The appraisal of selected *EAQ* studies (academic inquiries) employing the consideration of practical significance called into question the adequacy of statistical analyses and, thus, the value of these studies. Criteria for determining the credibility of operational research were viewed as intuitive and inseparable from concerns to improve methodology.

Since the intents of this appraisal of inquiry are to focus on research problems and questions and to explore new directions for improving inquiries in the area of decision-oriented research, it seems appropriate that this chapter should conclude by suggesting some future directions for the use of quantitative methods in educational administration. To address this issue, the 1973 University Council for Educational Administration (UCEA) monograph, *Quantitative Analysis in Educational Administration Preparation Programs*, was reexamined with a view to how its recommendations might be extended to take advantage of insights and directions encountered in more recent literature.[37]

Research on Schools

If one's interest is primarily oriented toward conducting research *on* schools or exploring recent developments in design and analysis, the following deserves investigation.

Theory Construction and Verification: Most writings on theory in educational administration appear to agree on the need for more adequate theories, but there is less consensus on what strategies would be most useful in constructing such theories. In the past several years, the literature in the social and behavioral sciences has contributed to the understanding of the process of moving from the verbal theories that abound in organizational studies to more rigorous formulations in terms of mathematical models.[38] This approach includes: (1) the possibility of causal analysis and inference without experimental manipulation, which is critically important in organizational studies where political, practical, and ethical problems narrow the possibilities for implementing classical experiments; (2) the opportunity to first construct causal diagrams and flowgraph analyses and then to specify the corresponding structural equations; and, finally, (3) the means to estimate and evaluate these theoretical systems from the standpoint of testing their correspondence with reality. In light of such developments, the author holds that it is both possible and desirable to invest in a sustained effort aimed toward a closer integration of theory-building with quantitative empirical research and mathematical-modeling.

Applications of Mathematical Models: A careful examination of current research in the social sciences suggests that a wide variety of statistical methods and mathematical techniques are applied to a number of the research problems typically encountered in organizational inquiries.[39] However, within educational administration efforts are still concentrated on elementary statistical tests, which are seldom very informative, particularly when the variables found to be associated are not thoroughly understood in advance. Moreover high statistical significance levels have often been misunderstood by the statistically naive as measures of association. To be sure, the reduction of research and theory-building to focus exclusively on mathematical studies should be avoided. On the other hand, it is important to explore more actively and persistently how mathematical models accurately applied in the social sciences could also be used to introduce greater precision into all administrative discourse.

One step in this direction might be a careful review of the correspondence between statistical and other mathematical methods (reported in the new twelve-volume monograph series on quantitative applications in the social sciences) and the type of data analysis problems frequently encountered in educational administration research.[30] Particular attention here should be given to methods such as the multivariate analysis of qualitative data to explore interactions among nonmetric or categorical variables, cohort analysis as an appropriate technique for either survey research designs or historical inquiries that rely on archival data, and time series analysis as a means to study change. Organizational theorists should specifically examine the monograph on ecological inference, which treats the research issue of failing to consider the possible effects of making inferences to individuals from aggregate data.[31] Any of these research issues (such as the multivariate analysis of qualitative data or the problem of ecological inferences) would provide more than an adequate framework for conducting a critical appraisal similar to the one offered for the distinction between practical and statistical significance in the *EAQ* studies.

Researchers with predilections toward ethnography and field study methods could profit from a careful examination of a recent three-part symposium on mathematical explorations in anthropology conducted at the annual meetings of the American Association for the Advancement of Science.[32] The findings of this symposium clearly indicate that anthropological methods are by no means completely incompatible with those of sociology, economics, or the administrative sciences, even when they focus on quantitative analytical techniques and similar methodologies.

Knowledge Synthesis: In a recent UCEA publication Culbertson notes that one purpose of investing in synthesis is to produce newly organized bodies of knowledge that reflect a restructuring of concepts and research findings about selected aspects of educational organizations or administrative leadership.[33] Although such efforts typically center on a specific discipline (such as the politics of education and the economics of education) or are interdisciplinary (for issues such as leadership), these need not proceed according to the homogeneity assumption—the case where all research entries are assumed to be of equal quality. The discussion of the distinction between statistical and practical significance illustrated how a critical review of research (one form of synthesis) might benefit from the use of a single quantitative technique, ω^2, to avoid acceptance of all reported findings as they appear in the literature.

Two more general quantitative strategies that can contribute important analytical insights in knowledge synthesis are secondary analysis and meta analysis. Consider the following. Statistical inference follows the so-called hypothetico-deductive paradigm, which consists of three steps: hypothesizing a model for something unobservable; deducing the observable consequences; and undertaking an empirical study to demonstrate that the consequences expected in the observations are actually observed in the data. If the data fit our expectations, we are encouraged to accept the model as an accurate representation of the unobservable reality. Since more than one model may have the same implications for the data one observes, our acceptance is always provisional and subject to modification as other findings or ideas for models become available. Secondary analysis enters at this point. It encourages investigators to test alternate conceptual models and usually proceeds by introducing different mathematical models to represent these alternate conceptual frameworks.[34]

Meta analysis involves a statistical reanalysis and integration of a large collection of prior empirical findings to produce more generalizable estimates of central tendencies and variability.[35] This form of statistical integration should be particularly beneficial in educational administration, since sampling plans employed in different studies often pose severe limitations regarding the external validity of individual studies.

Reporting Research Findings

If one's primary interest centers on reporting research findings or locating new quantitatively oriented research domains, the following deserve consideration.

Graphics and Reporting: Efforts to specify more effective strategies for reporting or disseminating quality empirical research findings—within the profession and to boards of education, public sector policy groups, or task forces and citizens' advisory councils—should consider emerging developments in social graphics—that is, the graphic representation of social indicators and other quantitative social data.

Initial explorations might concentrate on the efforts of the Graphic Social Reporting Project, which the Bureau of Social Science Research began in 1971. Originally, the project explored implications for social indicator reporting presented by recent developments in display and communications technology. Here the emphasis was on "kinostatistics," which include graphics in media other than the printed page, particularly cinematic and electronic media capable of kinetic, audiovisual communication; computer-generated rather than hand-drawn displays; and interactive rather than passive systems. More recently the project has been reoriented to consider as well the principles and practices of social graphics applicable to traditional and technologically simpler modes of representation. All project activities are synthesized and reported in a single bibliographic text with over one thousand entires and abstracts.[36] Less ambitious, but perhaps more immediately relevant for practicing administrators, are guidelines for reporting test scores developed by the National School Public Relations Association and the graphics reporting strategies for community action groups developed by the Institute for Responsive Education.[37]

Statistics as Legal Evidence: In their recently published text, *Statistics and Public Policy* (1977), Fairley and Mosteller have clearly specified the likely foci for contemporary courses in statistical methods taught in public policy programs located in schools of government, public affairs, and administration of law schools.[38] In addition to emphasizing the basic tools of probability and statistical inference, their introductory treatment not only illustrates statistical techniques with examples where policy plays a major role, but also points to themes related to statistics in the analysis of policy. Among these themes receiving increased attention is the issue of statistics as legal evidence.[39] Although their illustrations concentrate primarily on the application of conditional probability and the utility of Bayesian methods in presenting evidence to the courts, their discussions on the admissibility of alternate forms of data into a court of law are both extensive and insightful.

Efforts to elaborate and interpret such developments for educational policy analysis would appear to be a highly relevant research project for exploring new applications of mathematical models in educational administration. Findings from these inquiries should be of particular interest to urban school districts, which are consistently required by the courts to undertake and report the results of large-scale empirical studies that point to either the effectiveness of, or the unanticipated consequences following from, the implementation of mandated student and faculty intervention programs.

Research in Schools

If the primary interest centers on research *in* schools, one might consider the following development in operational research.

An Example: To provide some indication of the general direction of research-and-development in schools, the author examined the 118 large-scale operational research projects completed during the 1975-1976 school year by the Research and Evaluation Division of the Dallas Independent School District's Department of Research, Evaluation and Information Systems.[40] To be sure, this is an exemplary rather than typical department. The department has a current operating budget of approximately $4.7 million, with $2.5 million allocated to the research and evaluation division. This division has twenty-eight senior evaluators and project directors with earned doctorates and fifty additional support staff classified as evaluation specialists and technical support personnel. The department was formed during the 1969-1970 school year, when the district received a grant of $2.4 million dollars from a local foundation to support development activities in the district.

The Dallas Independent School District (DISD) is one of the seven largest Texas urban school districts that presently operate research and evaluation departments.[41] In *six* of these seven districts (which include Dallas), the general framework identified for allocating departmental resources, designing individual projects, and assessing the practical as well as standard scientific criteria for quality research is the CIPP model of evaluation developed by the Phi Delta Kappa National Study Commission on Evaluation. (CIPP represents an abbreviation for four general types of interrelated evaluation studies: context, input, process, and product evaluations.)[42]

This framework views operational research as the process of delineating, obtaining, and providing useful information for judging decision alternatives. For information to be useful, the model requires eleven criterion elements to be satisfied.

The first four criterion elements—internal validity, external validity, reliability, and objectivity—are designed to represent standard scientific criteria. Specifically, they deal with the characteristics of research design and analysis that allow one to make statements about relationships among the variables in a specific research study and the extent to which these relationships also apply for other settings and samples. Within this framework they are viewed as necessary but not sufficient conditions to judge the value of operational research.

The six practical criterion elements provide a useful way to look at operational research as an activity centrally concerned with the linkage between information and organized action. Although these six criterion elements are essentially intuitive, each explicitly or implicitly involves interaction with a receiver. The first three practical criteria—relevance, importance, and scope—are logically interrelated and are used to specify the boundaries for fact-finding, data collection, and data analysis. The other three practical criteria—credibility, timeliness, and pervasiveness—center on the communication of research findings, a point that Schutz notes is critical for understanding the differences between research *on* schools and research *in* schools.

The eleventh factor—the prudential criterion—deals with cost effectiveness decisions regarding the allocation of personnel, time, and other departmental resources to particular projects.

The eleven criterion elements lead to several comments on the operational research efforts in the DISD. Efforts to satisfy the traditional scientific criteria result in the following observations regarding future directions for quantitative methods in operational inquiries:

1. Most projects are supported by two sets of technical reports. The first set are published prior to implementation and treat the conceptual or theoretical base for projects as well as the validity, reliability, and other design issues one normally associates with standard scientific criteria. The second set of research reports are usually prepared following the completion of the project and include data analysis and the technical interpretation of results.

2. Alternative forms of multivariate analysis are frequently used in several of the 118 projects identified.

3. Experiments are often constructed to provide information for comparing and contrasting different instructional alternatives implemented within the district. In current research-and-development terms, these studies are more likely to be called natural rather than quasi-experimental designs.[43]

4. Formal statistical analyses include tests for the significance of relationships as well as those that test for the significance of differences. These tests often require a need to relate both cost and effect analysis.[44]

5. Since operational research designs frequently require measures on all sample units, several studies use descriptive as well as inferential statistics to more accurately represent school district parameters.

6. To improve the utility of demographic information, index numbers—similar to those used in other large-scale data reporting systems or social indicator projects—are developed.

7. Sampling procedures have also been developed to derive new information from data already contained in the district's computerized information base.

The attention given in the DISD to practical criteria of relevance, importance, and scope can be observed in the following trends:

1. To expand the scope of information presented to the Board of Education, several reviews of research on specific policy issues were undertaken and the findings presented during the 1975-1976 school year.

2. The importance of operational research as a continuing activity in the district can be seen in several studies that reflect an emphasis on longitudinal data, time series designs, and the effective use of archival data in cohort analyses.

3. Long-range planning appears to be an important domain of interest and includes extensive projection reports on enrollments, facilities, staffing, and finance.

4. The district's testing program reflects a priority to measure behavior in both cognitive and affective domains. Particular attention is given to accurate measurement and descriptions of the district's alternate "climates" for learning.[45]

5. The scope of analysis is also extended by developing and communicating to the Board of Education formal reports of exemplary instructional programs in other school districts. In these reports a deliberate effort is made to explain exactly how both quantitative and qualitative indicators were applied to determine the success of these instructional programs.

Efforts to satisfy the other three practical or user-centered criteria—credibility, timeliness, and pervasiveness—result in the following observations:

1. In addition to the two sets of technical reports, a brief (approximately four pages) abstract is prepared for each project completed by the department. In general, the abstract is nontechnical and includes summaries of the project's purpose, origin, design, and results.

2. The abstracts are published annually and widely circulated within the district. They are also available to other DISD patrons on request.

3. To increase the range of interest in evaluative information, the department meets regularly during the academic year with a subcommittee of the Board of Education.

4. To increase the use of the evaluative information, quarterly reports on the status of all operational inquiries in progress are forwarded to the superintendent.

5. To increase the number and type of requests for evaluative information, a special applied research group has been formed within the department to prepare ad hoc information requirements for the district.[46]

6. To increase daily interaction between the evaluation staff and other district personnel, several members of the department reside on project sites rather than in the central office.[47]

A more elaborate case analysis of the DISD and implementation of the CIPP model—not our primary intent—would involve an analysis of several additional organizational factors and administrative predilections that surround the context in which operational research is conducted and reported. To be sure, it would be

necessary to examine latent as well as obvious research priorities. Among the less obvious priorities for the application of mathematical models in the DISD would be: the district's administrative commitment to long-term program experimentation and revision based on operational findings;[48] the priority placed on reporting the accuracy of various types of data entered in the district's information system;[49] the goodness-of-fit between the research reporting schedule and actual decision dates in the district's administrative and instructional program calendars as well as the correspondence between reported index numbers and the individual measures they represent;[50] and a comparison of research costs with the costs of the decisions that will be made on the basis of the evaluative information (the prudential criterion).

Administrative Technology: The literature in educational administration has continuously referenced the value of employing so-called administrative technologies, which are usually found in the management science literature and in handbooks on organizational development and planning strategies. More specifically, these include techniques such as program evaluation and review techniques (PERT), management by objectives, program planning and budgeting system (PPBS), delphic inquiries, zero-based budgeting, survey feedback and consultation in organizational development, trend-impact analysis, educational production functions, decision tree analysis, linear programming, policy-capturing models, Monte Carlo simulations, nominal group techniques, functional and cost-centered budgeting, and cost-benefit analysis.

Academic and operational researchers, interested in reporting the practical utility of a particular technique but unwilling to spend time in school districts, may have systematically overlooked the most appropriate set of applications. Until the literature in educational administration, such as that recently inaugurated in the *Educational Researcher*, places a higher priority on publishing articles on research-and-development progress in schools, opportunities to conduct comprehensive critical appraisals, reviews, or syntheses of administrative technologies will remain largely more an ideal than a reality.[51]

Secondly, with respect to graduate training in educational administration, the actual design and successful implementation of administrative technologies in operational settings require a working knowledge of descriptive as well as inferential statistics and a general understanding of quantitative methods used in management operations.[52] University-based programs devoted to the preparation of school administrators (who must assume the responsibility for managing the research-and-development activities in school districts or other organizational settings) might increase their effectiveness by devoting explicitly a part of the formal preparation program to the application of quantitative methods and data reduction strategies that are essential for successful implementation of the administrative technologies.[53]

Utility of Mathematical Models and Quantitative Methods

If educational administration intends to seriously enter the debate on the utility of mathematical models and quantitative methods in either academic or operational research, the profession would be well advised to critically examine and reference the extensive social and policy science literature that addresses this topic.

In the immediate future we are likely to observe "point-counterpoint" discussions in educational administration on the value of mathematical models and quantitative models to advance the state of the art in decision-making,

research, or the development of theory. Although it is usually constructive to note particularly poor studies which in effect endorse an antitheoretical position by merely throwing a large inventory of variables into a regression equation with the intent of selecting out some subset that accounts for the most variance, or to discount the value of factor analytic inquiries by referencing studies where the investigators failed to employ any theoretical insights regarding the reduction of their original correlation matrices, these citations, taken as the last word, fail to address adequately the issues pertaining to either the limits or the advantages of mathematical models for educational administration.

Opportunities to enhance perspectives and to accurately define the relevant issues for debate have been treated extensively in the social and policy science literature, a knowledge base frequently claimed to be most appropriate for research and the instructional content of administrator preparation programs. If this literature is used for more careful fact-finding, researchers might study the following: the 1963 American Academy of Political and Social Science symposium, which treated the utility and inutility of mathematics in the study of economics, political science, and sociology;[54] the National Academy of Sciences reports on new directions in the mathematical sciences;[55] recommendations from the Association for Institutional Research on new directions for quantitative applications in academic administration;[56] and the survey of the social and behavioral sciences conducted under the joint auspices of the Committee on Science and Public Policy of the National Academy of Science and the Policy Committee of the Social Science Research Council. This survey indicates that schools of applied social research will turn to scholars trained in mathematics, logic, and operations research to assist in the development of new methodologies, alternate planning strategies, and programs of study relevant to public administrators.[57] To sharpen explanations for the limitations of mathematical models, the distinctions in the educational planning literature between teaching by the numbers and planning on the basis of numbers should be studied more carefully.[58] The emerging literature on management misinformation systems,[59] the number of "numbness" issue in administrative reporting,[60] the problems associated with the transfer of system analysis from the aerospace industry to public administration and policy studies,[61] and the critical appraisals of computer simulations to capture the dynamics of social systems[62] should be examined as well.

As a final word, the findings of Deutsch and his colleagues, who have identified and analyzed conditions favoring sixty-two major advances in the social sciences since 1900 should not be overlooked.[63] Their analysis indicates that the sixty-two major advances (achievements or breakthroughs) typically combined theory, methods, and results as opposed to one of these elements as a sole focus of interest. In light of these findings, they claim the long-standing quarrel about whether to emphasize theory, methodology, or empirical results seems "ill-conceived," since important advances in any one of these three aspects of social science is likely to lead to advances in the other two. It is of more than passing interest that Deutsch and his colleagues have observed that quantitative problems or findings (or both) characterize two-thirds of all major achievements in the social sciences between 1900 and 1965, and that five-sixths of these advances (those explicitly linked to quantitative problems and findings) were made since 1930.

Notes

1. Richard E. Schutz, "Research in Schools," *Educational Researcher* 5, no. 5 (May 1976). This position is similar to the distinction between decision-oriented and conclusion-oriented inquiry in Lee J. Cronbach and Patrick Suppes, eds., *Research for Tomorrow's Schools: Disciplined Inquiry in Education* (New York: Macmillan, 1969).

2. Operational research is sometimes viewed as "applied decision theory." In this chapter, operational research, or research in schools, refers to the application of scientific methodology to problems related to the functioning or operating of a specific organizational unit such as a public school district. For example, see J.E. Brooks, "Operational Research in Educational Administration," *Education and Urban Society* 3 (1970):7-40.

3. Portions of this section appeared in James F. McNamara, "Practical Significance and Statistical Models," *Educational Administration Quarterly* 14, no. 1 (Winter 1978):48-63. Reprinted with permission.

4. The author acknowledges his debt to the article by Richard E. Schutz, "The Control of 'Error' in Educational Experimentation," *School Review* 74, no. 2 (1966):151-158. Much of the design of this section and the secondary analysis of statistical tests reported for volumes 1 through 12 of the *Educational Administration Quarterly* parallels the treatment of practical significance presented in this source. Assistance in clarifying issues associated with the differences between statistical and practical significance and between tests for the significance of differences and tests for the significance of relationships was also found in Richard M. Wolf, "Data Analysis and Reporting Considerations in Evaluation," in W. James Popham, ed., *Evaluation in Education* (Berkeley, Calif.: McCutchan, 1974); and W. James Popham, *Educational Evaluation* (Englewood Cliffs, N.J.: Prentice-Hall, 1975).

5. Y.K. Shetty and H.M. Carlisle, "Application of Management by Objectives in a University Setting," *Educational Administration Quarterly* 10, no. 2 (Spring 1974):65-81. Although analysis here focuses only on the ANOVA results, several questions might also be raised regarding the credibility of the sampling plan, the failure to treat the nonresponse bias given a reported questionnaire return rate of 46 percent, the general integrity (validity) associated with the questionnaire, and the means by which questionnaire responses were aggregated and averaged to yield a single criterion measure.

6. For one such technique, ω^2, an excellent treatment appears in W.L. Hays, *Statistics for Psychologists* (New York: Holt, Rinehart and Winston, 1963). Some criticism of using ω^2 as an index of the strength of a statistical association is treated in Gene V. Glass and A. Ralph Hakstian, "Measures of Association in Comparative Experiments: Their Development and Interpretation," *American Educational Research Journal* 6, no. 3 (1969):403-414.

7. When a specific study is to be viewed as nonexperimental rather than experimental, some statistical handbooks (such as Hays in note 6) suggest that a more appropriate index for estimating variance is η^2. Specifically, η^2 is the squared "correlation ratio" that results when ANOVA designs are solved using multiple regression techniques. Hence, it is the ratio $SS(B)/SS(T)$. This index is also described in any text on linear models such as K.A. McNeil, F.J. Kelly, and J.T. McNeil, *Testing Research Hypotheses Using Multiple Linear Regression* (Carbondale, Ill.: Southern Illinois University Press, 1975). The η^2 values for the Shetty and Carlisle ANOVA results are 0.186, 0.077, and 0.028, which are slightly higher but do not represent any real departure in magnitude from the ω^2 estimates. The author will continue to use the ω^2 index in this analysis with the understanding that η^2 could also be readily calculated for any of the ANOVA test results.

8. Schutz, "Control of 'Error'.". Reprinted with permission of the University of Chicago Press. (© All rights reserved.) (One obvious exception to this approach is Raymond S. Adams et al., "School Size, Organizational Structure and Teaching Practices," *Educational Administration Quarterly* 6, no. 3 (Fall 1970):15-31. The seventy-two ω^2 estimates for this study appear in the column of table 10-2 labeled volume 1-6. All seventy-two index values were reported in the *EAQ* article along with an interesting discussion of the influence of these ω^2 estimates in interpreting the findings of the study.)

9. For another approach to interpreting standard statistical tests of significance of studies reported in the *EAQ*, see the 1972 appraisal of educational research reported in J.K. Brewer, "On the Power of Statistical Tests," *American Educational Research Journal* 9, no. 3 (1972):391-401. For those who wish to use this model, it is suggested that careful attention be given to the different cases described in J. Cohen, *Statistical Power Analysis for the Behavioral Sciences*, 2d ed. (New York: Academic Press, 1976).

10. For example, see the author's discussion of an alternate statistical model for the Shetty and Carlisle study in "Practical Significance and Statistical Models," *Educational Administration Quarterly* 14, no. 1 (Winter 1978):48-63.

11. A more exact interpretation is the hypothetico-deductive paradigm for statistical inference, which consists of three steps: hypothesizing a model for something unobservable, deducing the observable consequences of the models, and undertaking an empirical investigation with the intent to test whether the consequences expected in the observations are actually apparent in the data. If the data fit expectations, the investigator is encouraged to accept the model as a correct representation of the unobservable reality. However, acceptance is always provisional. If the data do not conform to expectations--clearly the case for several *EAQ* findings--something is wrong. Since there are several valid reasons for the failure to meet expectations, the author suggests that these study findings be viewed with caution. For example, the models may be invalid, the deductions for model consequences could be incorrect, or the actual data could be inadequate or defective. A more detailed treatment of the consequences of statistical inference in model construction is given in R. Darell Bock, *Multivariate Statistical Methods in the Behavioral Sciences* (New York: McGraw-Hill, 1975).

12. See note 8.

13. Cohen (in *Statistical Power Analysis*) suggests the following operational guidelines for the behavioral sciences in terms of correlation coefficients: for small effects, $r = 0.10$; for medium effects, $r = 0.30$; and for large effects, $r = 0.50$. His position implies that a large effect would be encountered when at least 25 percent of the variance of the dependent variable is attributable to the independent variable.

14. See W. Anderson, "How Not to Let Your Board and Superintendent Be Hoodwinked by 'Research'," *American School Board Journal* 9, no. 3 (1978):391-401.

15. James F. McNamara and David H. Gill, "Practical Significance in Vocational Education Research," *Journal of Vocational Education Research* (forthcoming).

16. McNeil, Kelly, and McNeil, "Testing Research Hypotheses."

17. This excerpt from "An Overview" by Ilene N. Bernstein is reprinted from *Sage Contemporary Social Science Issues* 23 (1976):8 and originally appeared in *Sociological Methods & Research* by permission of the publisher, Sage Publications, Inc. The discussion of problem formulation and sample selection relies extensively on this source.

18. For example, see Harvey A. Averch et al., "How Effective is Schooling? A Critical Review and Synthesis of Research Findings," Rand Corporation, Santa Monica, California (March 1972), R-956/?CSF/RC.

19. For a recent study following this format, and one illustrative of what is

implied by Schutz's reference to an extraschool-agency initiative, see Anita A. Summers and Barbara L. Wolfe, "Which School Resources Help Learning Efficiency and Equity in Philadelphia Public Schools?," *Federal Reserve Bank of Philadelphia Business Review* (February 1976).

20. These design considerations are detailed in Richard J. Murnane, *The Impact of Resources on the Learning of Inner City Children* (Cambridge, Mass.: Ballinger, 1975), p. 25.

21. Murnane, *Impact of Resources*. The description of Murnane's research has been taken directly from this source. The model descriptions presented in this section are represented in a slightly different notation, but the functional forms are consistent with those provided in the Murnane text.

22. These hypotheses are detailed in ibid., chaps. 3, 4.

23. Ibid., p. 33.

24. Most of the hypotheses of the study were tested using one-tailed *t* tests. Some were tested using two-tailed tests as indicated in ibid.

25. A summary of the information used to test these three hypotheses appears in ibid., table 3-1, p. 35.

26. Reprinted by permission of the publisher, from Eric A. Hanushek, *Education and Race: An Analysis of the Educational Production Process* (Lexington, Mass.: D.C. Heath and Company, 1972), p. 125. Copyright 1972, D.C. Heath and Company.

27. See James E. Bruno and James N. Fox, *Quantitative Analysis in Educational Administrator Preparation Programs*, ERIC/UCEA Series on Administrator Preparation (Columbus, Ohio: University Council for Educational Administration, 1973). More recent interpretations by James E. Bruno are given in *Educational Policy Analysis: A Quantitative Approach* (New York: Crane, Russak and Co., 1976).

28. See Hubert M. Blalock, Jr., *Theory Construction: From Verbal to Mathematical Formulation* (Englewood Cliffs, N.J.: Prentice-Hall, 1969). See also David R. Heise, *Causal Analysis* (New York: Wiley, 1975); Herbert B. Asher, *Causal Modeling*, Series on Quantitative Applications in the Social Sciences no. 3 (Beverly Hills, Calif.: Sage Publications, 1969); and James G. Anderson, "Causal Models in Educational Research: Nonrecursive Models," *American Educational Research Journal* 15, no. 1 (Winter 1978):81-98.

29. For organizational studies see Rocco Carzo and John Yanouzas, *Formal Organization: A Systems Approach* (Homewood, Ill.: Dorsey Press, 1967).

30. Eric M. Uslaner, ed., *Series on Quantitative Applications in the Social Sciences*, nos. 1-12 (Beverly Hills, Calif.: Sage Publications, 1977).

31. This is generally treated in the literature under the title, "ecological fallacies." See Laura I. Langbein and Allan J. Lichtman, *Ecological Inference*, Series on Quantitative Applications in the Social Sciences, no. 10 (Beverly Hills, Calif.: Sage Publications, 1977); and Irving H. Siegel, *Aggregation and Averaging*, Methods for Manpower Analysis no. 1 (Kalamazoo, Mich.: W.E. Upjohn Institute for Employment Research, 1968).

32. Paul Kay, ed., *Explorations in Mathematical Anthropology* (Cambridge, Mass.: MIT Press, 1971). See also the discussions of enumeration and the use of descriptive statistics in Harry F. Walcott, "An Ethnographic Approach to the Study of School Administrators," *Human Organizations* 29 (1970):115-122, and his book *The Man in the Principal's Office: An Ethnography* (New York: Holt, Rinehart and Winston, 1973).

33. Jack Culbertson, "Linking Agents and the Sources and Uses of Knowledge," in N. Nash and J. Culbertson, eds., *Linking Processes in Educational Improvement* (Columbus, Ohio: University Council for Educational Administration, 1977).

34. Leigh Burstein, "Secondary Analysis: An Important Resource for Educational Research and Evaluation," *Educational Researcher* 7, no. 5 (May 1978):9-12.

35. Gene V. Glass, "Primary, Secondary and Meta Analysis of Research," *Educational Researcher* 5, no. 10 (November 1976):1-4.

36. Barry M. Feinberg et al., *Social Graphics*, The Graphics Social Reporting Project (Washington, D.C.: Bureau of Social Science Research, Inc., 1975).

37. See *Releasing Test Scores: Educational Assessment Programs, How to Tell the Public* and *Putting Words and Pictures about Schools in Print* (Arlington, Virg.: National School Public Relations Association); Lloyd Prentice, *Words, Pictures, Media: Communication in Educational Politics* (Boston: Institute for Responsive Education, 1976).

38. William B. Fairley and Frederick Mosteller, *Statistics and Public Policy* (Reading, Mass.: Addison-Wesley, 1977). Additional insights on selecting, conducting, and reporting statistical analysis in public policy studies appear in Arnold J. Meltsner, *Policy Analysis in the Bureaucracy* (Berkeley, Calif.: University of California Press, 1976).

39. Hans Zeisel, "Statistics as Legal Evidence," *International Encyclopedia of the Social Sciences* 15 (1968):246-247; and R. Cullison, "Identification by Probability and Trial by Arithmetic: A Lesson for Beginners in How to Be Wrong with Greater Precision," *Houston Law Review* 6 (1969):471-483.

40. Each of the studies is described in William J. Webster, *Abstracts of Research and Evaluation Reports* (Dallas, Tex.: Dallas Independent School District, Department of Research, Evaluation, and Information Systems, December 1976).

41. See Edward M. Jackowski, "The Functions, Products and Financial Support of Urban School District Research Departments in Texas" (Ph.D. diss., Department of Educational Administration, Texas A & M University, December 1974).

42. Daniel I. Stufflebeam et al., *Educational Evaluation and Decision Making*, Report of the Phi Delta Kappa Commission on Evaluation (Itasca, Ill.: Peacock, 1971).

43. See, for example, the discussion of natural experiments and ecological validity in Urie Bronfenbrenner, "The Experimental Ecology of Education," *Educational Researcher* 5, no. 9 (October 1976):5-15; and the description of heuristic experiments in Abraham Caplan, *The Conduct of Inquiry* (San Francisco: Chandler, 1964).

44. This procedure is described in William J. Webster, "Cost and Effect Analysis: An Example," *Educational Economics* 1, no. 3 (1976):10-16.

45. See William J. Webster, "What's the Score on Testing?" (Paper presented at the Thirty-fourth Annual Convention of the National School Boards Association, Houston, Texas, April 6, 1974).

46. See William J. Webster, "The Organization and Function of Research and Evaluation in a Large Urban School District" (Paper presented at the Annual Meeting of the American Educational Research Association, Washington, D.C., March 31, 1975).

47. This is especially true for the department's Developmental Project Branch, responsible for process and outcome evaluations of new and innovative instructional programs undertaken on an experimental or trial basis.

48. See Nolan Estes, *Marshalling Community Leadership to Support the Public Schools* (Bloomington, Ind.: Phi Delta Kappa Educational Foundation, 1975).

49. On the importance of accuracy in school information systems, see Henry Dyer, *How to Achieve Accountability in the Public Schools* (Bloomington, Ind.: Phi Delta Kappa Educational Foundation, 1973).

50. Ibid., pp. 32-34.

51. The value of these strategies is well illustrated in William Foley, "Analysis and Educational Decision Making: Toward a Theory into Practice" (Doctoral Thesis, Department of Educational Administration, Teachers College, Columbia University, August 1976).

52. Robert J. Thierauf, *Decision Making through Operations Research* (New York: Wiley, 1970); and Russell L. Ackoff and Patrick Rivett, *A Manager's Guide to Operations Research* (New York: Wiley, 1963).

53. Similar recommendations are given in Robin H. Farquhar, "The Social Sciences in Preparing Educational Leaders," in J. Culbertson et al., eds., *Social Science Content in the Preparation of Educational Leaders* (Columbus, Ohio: Merrill, 1973); and Lewis B. Mayhew and the Stanford University University School of Education Committee on Administration and Policy Analysis, *Educational Leadership and Declining Enrollments* (Berkeley, Calif.: McCutchan, 1974), especially pp. 179-180.

54. James C. Charlesworth, ed., *Mathematics and the Social Sciences* (Philadelphia: The American Academy of Political and Social Science, 1963).

55. Harvey Brooks, ed., *The Mathematical Sciences* (Washington, D.C.: National Academy of Sciences, 1968).

56. David P. Hopkins et al., eds., *Applying Analytic Methods to Planning and Management*, New Directions for Institutional Research, no. 13 (San Francisco: Jossey-Bass, 1977).

57. William Kruskal, ed., *Mathematical Sciences and Social Sciences* (Englewood Cliffs, N.J.: Prentice-Hall, 1970).

58. Russel G. Davis, *Planning Human Resource Development: Educational Models and Schemata* (Chicago: Rand McNally, 1966).

59. Russell A. Ackoff, "Management Misinformation Systems," *Management Science* 14 (December 1967):B147-155.

60. W. David Maxwell, "Number Numbness," *Liberal Education* 59, no. 4 (December 1973):405-416; and Frederick W. Hill, "Statistics, Liars, and Figures," *American School and University* 48, no. 3 (November 1975):19-20.

61. Ida R. Hoos, *Systems Analysis in Public Policy: A Critique* (Berkeley, Calif.: University of California Press, 1972).

62. David Berlinski, *On Statistical Analysis: An Essay Concerning the Limitations of Some Mathematical Methods in the Social, Political and Biological Sciences* (Cambridge, Mass.: MIT Press, 1976).

63. Karl W. Deutsch et al., "Conditions Favoring Major Advances in Social Science," *Science* 171, no. 3970 (1971):450-459.

survey research techniques 1980

33rd ANNUAL SUMMER INSTITUTE
CONDUCTED BY THE
SURVEY RESEARCH CENTER

June 30 — August 22, 1980

The Survey Research Center is part of the Institute for Social Research, situated on the central University campus at 426 Thompson Street in Ann Arbor.

The Survey Research Center was established at The University of Michigan in 1946 on an interdepartmental and interschool basis in order to interact effectively with all parts of the University and to perform five major functions:

(1) Provide a well trained staff and research capability for conducting surveys on economic and social problems;

(2) Conduct methodological research for the improvement and development of survey procedures;

(3) Help in the integration of the social sciences by providing facilities for research on interdisciplinary problems;

(4) Foster theoretical advancement in the social sciences based on new data from interdisciplinary research;

(5) Provide graduate training in all phases of survey methodolgy.

ISR

Institute for Social Research
The University of Michigan
Ann Arbor, Michigan

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THE ANNUAL SUMMER INSTITUTE

The annual Summer Institute is a special training session in survey research techniques conducted by the Survey Research Center staff through the graduate departments of Sociology and Psychology at The University of Michigan. The program uses the sample interview survey as a basic instrument for the scientific measurement of human activities, and is designed to meet some of the educational and training needs of people engaged in business and government research and of graduate students and university instructors interested in quantitative research in the social sciences.

This year the Institute will offer two consecutive sessions; the first from June 30 (Registration Day) through July 25 and the second session, July 28 through August 22.

Depending upon the qualifications and needs of the applicant, the Summer Institute benefits people with various backgrounds: For the student with minimum survey experience, participation in the Summer Institute should be thought of as a full-time activity, and the entire eight weeks should be reserved for Summer Institute classes and activities, exclusive of outside work obligations and additional University courses. During the course of the Institute, students can become acquainted with survey methods – study design, questionnaire construction, interviewing, coding, methods of analysis, sampling, and computer technology – as applied to the problems of business, public health, education, industry, and government, or as used in general social science research.

Since the survey techniques used in the above courses are basically statistical, the Summer Institute student must have a working knowledge of concepts and procedures in elementary statistics. These include measures of central tendency and dispersion, the normal distribution and its properties, product moment and rank order correlations and tests of significance of differences in means and proportions. If a student lacks this prerequisite, most of the Summer Institute is not suitable.

A student with modest or no previous survey research experience is advised to elect the Psychology-Sociology 561-562 sequence (Survey Research Design-Survey Research Data Collection) for the entire eight-week period.

In addition, if a student's statistical background meets the minimum level described above, s/he could select Analysis of Survey Data (Psychology-Sociology 616) during the first four weeks.

During the second four-week session, s/he could also select Data Processing with OSIRIS (Psychology 710-Sociology 719).

For the advanced student with specific interests in sampling, Methods of Survey Sampling (Psychology 687-Sociology 612) is available during the first session, as is Advanced Methods of Survey Sampling (Psychology 618-Sociology 613) during the second session. The Workshop in Sampling Techniques is an added option for those interested in highly specialized an intensive work in sampling problems.

In general, the Sampling and Analysis courses are limited to persons who possess either considerable survey experience or graduate training in quantitative methods, but who are limited in survey experience. These courses may be elected independently of others, provided the student has the skills, background, and experience to handle them.

For the special, professional-level "mini courses," this summer's topic will be offered under the course title "Study Designs in Survey Research" (Phychology 684-Sociology 614). For additional information, see course description on pages 5 and 6.

If you are undecided as to whether or not you qualify for any of the advanced courses, please write to the Center indicating your relevant course background and working experience. The Center will also be happy to supply a reading list for Summer Institute courses and a study guide for Statistics for those wishing to review materials in advance.

NOTE: During each four-week session, a student may elect no more than two courses. This two-course-per-period load assumes the student has full time to devote to these activities. Students who concurrently enroll in other University courses or instututes and/or hold a part-time job should, in most cases, enroll in only one Institute course per session.

For maximum benefit, each student is urged to enroll for the full eight weeks; however, a student may earn credit for either of the four-week sessions, if it is impossible to attend both.

DESCRIPTION OF COURSES OFFERED

First Session – June 30-July 25

Psych. 561 – Soc. 561
Survey Research Design (2 credit hours) Staff. June 30 - July 25. Prerequisite: Elementary statistics course. Designing a survey is a complex process. The various steps or phases are interdependent and require an appreciation of everything that happens in a survey. This course deals with all steps from the initial problem through development of the survey questionnaire and sampling design. The course consists of lecture-discussions coupled with work-group practicum experience in designing and developing a survey.

This course will benefit students who want an overview of all the steps in the survey process, as well as those who want experience before conducting their own survey.

Because of the practicum nature of the course, considerable time is required outside of class for committee work. Auditors are expected to participate in this work.

Psych. 683 – Soc. 621
Workshop in Sampling Techniques I (2 credit hours) Kish and Kalton. June 30-July 25. Prerequisite: Permission of instructor, only to students enrolled in Soc. 612-Psych. 687. Varied and graded exercises arising from common survey situations. Time spent working in groups under experts' guidance on lists, maps, data, and designs. Exercises in selection; selection techniques; segmenting and listing; stratification; two-stage sample of a city; faulty lists; simple replications; and a national sample.

Psych. 687 – Soc. 612
Methods of Survey Sampling (2 credit hours) O'Muircheartaigh. June 30 - July 25. Prerequisite: Two courses in statistics (The 81 pages noted in the preface to Survey Sampling by Kish are helpful.) A moderately advanced course in applied statistics, with emphasis on practical problems of design, this class deals with probability sampling, including stratified, clustered, and multistage; unequal probabilities and PPS, area sampling, ratio means, sampling errors, frame problems, cost factors, practical designs and procedures. Emphasis is placed on the meaning and application of variance formulas, not their derivations.

Psych. 616 – Soc. 616
Analysis of Survey Data (2 credit hours) Andrews. June 30-July 25. Prerequisite: (1) Completion of at least one graduate-level course in statistics (or instructor-approved equivalent in experience with statistics); should have a working familiarity with statistics, such as product-moment correlation and analysis of variance. Students may be asked to demonstrate their competence in statistics. (2) Basic familiarity with survey research methods. Topics to be covered are logic and methods of survey analysis, measurement theory and evaluation, scaling and index construction, univariate distributions, analysis of relationships (bivariate and multivariate); as time permits additional topics will include panel data analysis and causal analysis.

Second Session – July 28-August 22

Psych. 562 – Soc. 562
Survey Research Data Collection (2 credit hours) Staff. July 28-August 22. This course is a continuation of the work covered in Psych.-Soc. 561, although it can be elected independently. It starts with an available interview schedule or questionnaire, and covers interviewer training, interviewing, and coding. The course consists of lecture-discussions and demonstrations, coupled with individual and work-group practicum experience in these phases of a survey.

Like Psych.-Soc. 561, the practicum nature of the course requires considerable time outside of class for committee or individual assignments, and auditors are expected to participate in this work.

Psych. 686 – Soc. 623
Workshop in Sampling Techniques II (2 credit hours) Kish and Kalton. July 28 - August 22. Prerequisite: Permission of instructor, only for students enrolled in Psych. 682-Soc. 621, Psych. 687-Soc. 612, and Psych. 618-Soc.613. Samples of three countries; SRC's national sample; CPS of the Census Bureau; sampling establishments; agricultural surveys; regression estimators; computing and presenting sampling errors; multipurpose designs; controlled selection; retaining changed units; samples in censuses.

Psych. 618 – Soc. 613
Advanced Methods of Survey Sampling (2 credit hours) O'Muircheartaigh. July 28-August 22. Prerequisite: Psych. 687-Soc.612. Special problems and techniques; nonsampling errors and biases; designs of complex samples; case studies; frame problems; periodic and overlapping samples. Subclasses; optimal allocation; double sampling; controlled selection; simple replication methods and BRR for analytical statistics.

Psych. 684 – Soc. 614
Study Designs in Survey Research (2 credit hours) Cannell, Groves, and staff. July 28-August 22. This course will cover design and data collection methods which are unique to telephone surveys. It is assumed that the student is familiar with methods used in personal interview surveys. The course will discuss the adapatation and modification of those techniques to telephone surveys. It will include design and procedures of sampling, questionnaire constructions, interviewing techniques of telephone surveys. Examples from a variety of surveys will be presented.

Attention will be given to the administrative and technical operation of a telephone survey, including interviewer training, supervision, monitoring and administration. Methodological investigations of coverage, sampling, nonresponse, and response errors in telephone surveys will be discussed. A computer-based, on-line telephone system will be described and demonstrated.

Students electing Psychology 684 – Sociology 614 for credit should note that only a grade of "Satisfactory" or "Unsatisfactory" will be given for this course.

Psych. 710 – Soc. 719
Survey Research Data Processing with OSIRIS (2 credit hours) Klem. July 28-August 22. Prerequisites: Elementary knowledge of survey methods and basic statistics. The course will cover the steps needed to take data prepared on punched cards through the stages of checking, cleaning and building of self-described computer files to preliminary analysis. The OSIRIS IV computer software package for the management and analysis of social science data will be used. Emphasis will be practical, and problems will be run on the University of Michigan's Amdahl 470V/7.

TENTATIVE TIME SCHEDULE

All classes meet Monday through Friday at the hours shown on the right:

June 30-July 25

Psych. 683-Soc. 621	8 a.m.-12 p.m.
Psych. 616-Soc. 616	8 a.m.-10 a.m.
Psych. 561-Soc. 561	10 a.m.-12 p.m.
Psych. 687-Soc. 612	1 p.m.- 3 p.m.

July 28-August 22

Psych. 686-Soc. 623	8 a.m.-12 p.m.
Psych. 710-Soc. 719	8 a.m.-10 a.m.
Psych. 562-Soc. 562	10 a.m.-12 p.m.
Psych. 618-Soc. 613	1 p.m.- 3 p.m.
Psych. 684-Soc. 614	1 p.m.- 3 p.m.

ADMISSION REQUIREMENTS

Because all Summer Institute courses are a part of University department offerings, all students must be admitted through appropriate admissions offices. (This process may be started by returning the enclosed Preliminary Enrollment Record to the Center Director's Office.)

The following types of enrollment are avilable at the University:

Undergraduate Credit

Students who wish to earn undergraduate credit will be granted admission on the basis of their qualifications and experience. Students interested in electing courses on this basis should write to the Survey Research Center for an application, stating their present occupation and giving a brief resume of their work experience and educational background.

Students in good standing in any accredited school who wish to enroll in the Summer Institute and who plan to return thereafter to their former colleges, may apply for admission as "Summer Term Only" students. They will not be required to furnish transcripts but instead can submit a brief form (supplied by the Survey Research Center upon request) filled out by the Dean or Registrar verifying their good standing.

Graduate Credit

A student holding a bachelor's degree who wishes graduate credit may either apply for enrollment as a Special Student (in which case credit may be transferred to an institution where s/he is currently pursuing graduate work) or may seek admission to the Horace H. Rackham

School of Graduate Studies for the summer term only. A student who is not currently pursuing graduate work should propose this latter alternative by submitting a transcript and supplying other requisite information.

A student applying for Special Student status need not supply transcripts, but may instead submit a brief form (supplied by the Survey Research Center), filled out by the Dean or Registrar verifying the student's good standing at his/her institution.

Admission as a special student may also be granted to qualified applicants who are beyond the bachelor's degree — those not presently enrolled in graduate study who wish to elect courses for credit, but who do not seek a graduate degree at The University of Michigan.

In some instances, students may wish to enroll in Graduate School without seeking academic credit; if so, they should register as Visitors. Such students have the privileges of regular students, do the same work, (although they are excused from final exams), and the course appears without a grade on their transcript. Students registering in the Graduate School for credit or as Visitors pay the same fees.

All completed applications and transcripts, both for graduate and undergraduate admission, should reach Ann Arbor by May 15, 1980, for Michigan residents and by May 1 for non-residents.

Visiting Scholars

Individuals holding the Doctor of Philosophy degree who do not wish a record to be kept of their work may apply for guest privileges which permit them to attend lectures and use some University facilities without charge, exclusive of computer time. By submitting certification of having been awarded the Ph.D. degree, application for appointment as a Summer Institute Visiting Scholar in the Horace H. Rackham School for Graduate Studies is processed through the Survey Research Center.

Special Auditors

Mature persons whose education is no longer limited by degree and credit requirements can avail themselves of listening privileges in courses of their choice by enrolling as special auditors. No particular background is required, although the person should be qualified to profit from the experience.

REGISTRATION AND FEES

Because of the short summer term at the University, the Survey Research Center teaching staff believes it imperative that the following schedule be closely adhered to.

June 30 – First Session classes begin at 8 A.M. and continue throughout the day.

June 30-July 1 – Official Registration Days

July 4 – National Holiday

July 25 – Examinations; First Session ends

July 28 – First day of Second Session

August 22 – Examinations

Registration for the Second Session of the Summer Institute will take place on July 28, or before. Those people who plan to attend only the Second Session should consult with the Director's Office before proceeding with registration at other University offices.

The following information on tuition and fees is intended for visiting summer students only. Comparable information for degree-seeking University students already enrolled in undergradrate or graduate programs is available through the University Office of the Registrar.

Fees for Michigan residents (for first and/or second session) are as follows:

Undergraduate:
- 2 credit hours $114
- 4 credit hours $228
- 6 credit hours $341
- 8 credit hours $341

Graduate
- 2 credit hours $208
- 4 credit hours $416
- 6 credit hours $467
- 8 credit hours $457

Special Auditor's fee $125

Fees for non-residents (first and/or second session) are:

Undergraduate
- 2 credit hours $328
- 4 credit hours $656
- 6 credit hours $982
- 8 credit hours $982

Graduate
- 2 credit hours $456
- 4 credit hours $912
- 6 credit hours $1,022
- 8 credit hours $1,022

Special Auditor's fee $375

In addition to tuition fees listed above, all students will be assessed approximately $22 by the University for various campus services.

NOTE: Fees are subject to change at any time by the Board of Regents of the University.

UNIVERSITY PRIVILEGES

As registered University students, all Summer Institute participants are eligible to use many University facilities. These include University libraries, classrooms, housing, and recreational areas. University golf courses, inside swimming pools, and numerous tennis courts are available on or near the campus.

HOUSING

Students attending the Summer Institute may obtain information on housing by writing directly to the Housing Office, 1011 Student Activities Building, University of Michigan, Ann Arbor, Michigan 48109. Telephone 313-763-3164.

Although 1980 rates will be higher, 1979 residence hall rates for eight weeks ranged from $212 for a double room without board to $525 for a single with board. For students attending a four-week session during 1980, rates for room only will be approximately $10 a day.

Meals will be served in dormitories, but are optional, and students wishing to reserve a room only may be assigned to a dormitory where meals are not served. For those living in other residences, the Michigan Union and the Michigan League provide cafeteria and dining room service. There are also a number of restaurants in the vicinity of the campus.

UNIVERSITY APARTMENTS

The University maintains over 1,700 apartments for staff and student families. These include efficiencies, one-, two-, and three-bedroom units. Most of the units are modestly furnished.

Prices start at $160 a month for a furnished efficiency, with a limited number of spaces made available to single graduate students and Visiting Scholars.

Students enrolling for the Summer Institute courses should so indicate when requesting applications for housing – and should also include the dates of the session they plan to attend. In addition, those not-for-credit students, that is, Visiting Scholars and Special Auditors, should include the following information when requesting applications for residence hall housing: a copy of admission certificate, social security number, and birthdate.

Inquiries about the Summer Institute should be addressed to Helene J. Hitchcock, Administrative Manager, Office of the Director, Survey Research Center, University of Michigan, Ann Arbor, Michigan 48106. Telephone 313-764-8365.

I. V.

School of Library and Information Science

Curriculum in Library Science, Information Science, and Educational Media

Goals and Objectives

I Introduction

The educational program in the School of Library and Information Science combines theory with application and is designed not only to prepare new professionals for information service activities, but to provide practitioners with the opportunity to keep abreast of new developments.

Through research, through professional activities of both faculty and students, and through educational efforts, the School maintains an awareness of the needs and problems existing in the community which it serves.

To guide its program, the School has developed this Statement of Goals and Objectives.

Throughout this statement the term "information" is to be interpreted in its broadest sense: "Facts, data, visual or aural representations which convey meaning or elicit feelings." Thus "information" includes informational materials, as well as self-fulfillment and enrichment materials, in all possible formats. "Information professionals," as used in this document, includes librarians as well as information specialists.

II Goals

A Education:

To provide the student with a theoretical base for understanding the nature of information and informational materials, the processes by which they are created and communicated, and their organization for use, as well as the environment within which the information professional operates.

To relate theoretical concepts to practical applications, and to provide the student with the necessary skills to function as a responsive and responsible professional in a variety of specialized roles.

B Research:

To encourage a spirit of inquiry and criticism and to advance the theory and practice of the information profession through research and publication.

C Service:

To contribute to the growth and development of information professionals, libraries, information agencies, and professional organizations, and through them, of society.

III Objectives

A Education:

1 Theoretical Knowledge:

a To stress the interdisciplinary nature of library and information science through the study of relevant theories and methodologies drawn from related areas such as communications, education, linguistics, psychology, operations research, public administration and information technology.

b To develop an understanding of the intellectual bases of information generation, communication and dissemination.

c To acquaint students with the structure and content of the literature in a variety of subject fields, and to develop the necessary bibliographic skills to control and utilize it.

d To encourage a strong commitment to the principles of intellectual freedom and freedom of access to information.

e To acquaint students with the environmental determinants (social, economic, political) which affect information services, with emphasis on user/non-user needs, and the interrelationships among differing information systems.

f To familiarize students with research methods appropriate to the study of information services and to develop ability to apply these methodologies to the solution of specific problems. To develop analytical and evaluative attitudes toward research, practice and the profession.

2 Practical Knowledge:

a To develop the student's ability to relate theory to practice and to acquire specific skills for library and information work by encouraging problem-oriented projects and field experience.

b To encourage in students sensitivity and empathy toward others in order to enhance their performance in organizations and in public service.

c To develop the mastery of the basic elements of a library or information specialty or group of specialties.

d To familiarize students with the range of information formats, and the technologies appropriate to produce and use them effectively.

e To provide students with opportunities for the development of individualized programs of study based on personal career goals.

f To encourage contacts with the professional field through visits, lectures, special events, and to assist students with their placement in the profession.

B Research:

1 To encourage research wherever appropriate in course work, applications projects, independent study, and thesis research.

2 To provide opportunity for the study of research findings from our own and other disciplines as they may apply to the information field.

3 To encourage and facilitate student research projects which may lead to re-examinaton and revision of currently held concepts regarding information problems.

4 To encourage faculty research involvement which leads to improved teaching, greater awareness of current information problems, and a sense of excitement inherent in the discovery process which conveys itself to, and therefore benefits, the students.

C Service:

1 To provide educational opportunities for the professional development of information practitioners in the field.

2 To promote the improvement and development of information services by providing consulting and research assistance.

3 To encourage active participation by faculty and students in professional organization activities at all levels.

What Does the Information Professional Do?

The dramatic technological advances in today's society have made such an impact on libraries and information centers that the role of the information professional is constantly changing and expanding to meet the accelerating demands of all users of information.

Information is handled in many different systems, and each system serves many different communities, each with its own needs, interests, and outlook. The information cycle basically includes the creator, the processor, and the consumer of information. The ultimate aim of any information system is to connect the user, quickly and efficiently, to the proper information.

Libraries in the traditional sense make up one significant link in the information cycle; a variety of other information facilities closely related to libraries have been established for the purpose of collecting, processing, and distributing documents or data of a specialized nature. Depending upon the specific functions performed, these are designated as information centers, clearinghouses, information exchanges, archives, media centers, etc.

The elements of work in information agencies are performed by information professionals known as librarians, information scientists, information specialists, subjects specialists, bibliographers, archivists, media specialists, etc. Although there is a certain commonality of functions in these positions, the elements of work differ or are conditioned by: (a) the goals of the information facility; (b) the requirements of users of the service; and (c) the academic background and experience needed to perform the various functions.

Typical functions performed by information professionals include:*

1 *Managing.* The administration of a library or an information facility; the coordination of all the information elements into an integrated system anticipating user requirements.

*Adapted from U.S. Civil Service Commission. Bureau of Programs and Standards. *Guide for the Classification of Positions Providing Professional-Level Library and Information Services.* Washington, D.C.: U.S. Government Printing Office, 1966. pp. 335-339, 377-378, 396-397.

2 *Selecting Materials.* Planning the nature, variety, and depth of materials to be included in the information service; determining the needs of potential users, current and future demands; choosing the specific items to be acquired.

3 *Acquiring Materials.* The process of identifying, finding, and obtaining copies of information materials not already in the information agency.

4 *Cataloging.* The process of identifying a unit of information to distinguish it from other items; describing it bibliographically and organizing and recording the data in a methodical arrangement.

5 *Classifying.* The examination of materials in order to understand the intellectual content, to identify and select significant concepts and characteristics to be recorded as reference points for use in retrieval operations, and to organize them in a systematic arrangement.

6 *Indexing.* The detailed examination of source materials in order to understand the lectual content, to determine the essential features of the information, and to select points of view that are considered to be of sufficient importance to warrant the effort of rendering them searchable in the system.

7 *Abstracting.* Summarizing units of publication so as to present in concise form the needed bibliographic and/or subject information.

8 *Assisting Readers.* Including all the services which help in the effective use of the library by fitting books to the personal needs of the individual reader.

9 *Reference Work.* Meeting the information needs of users by making materials available, by answering specific questions, and by finding particular information.

10 *Literature Searching.* The systematic, comprehensive, or exhaustive search for information bearing on a specific problem or subject, performed as a service for specialists engaged in research or other scientific or technical work.

11 *Researching with Information.* Solving research problems, without recourse to experimentation, by gathering, analyzing, and interrelating information from a combination of sources.

12 *Compiling Bibliographies.* Locating, identifying, and compiling lists of books, articles,

pamphlets, technical materials, etc., related by subject, bibliographic, and/or user criteria.

13 *Translating.* Converting from one natural language, or its symbolic form, into another natural language with complete preservation of the meaning of the original

14 *Interpreting Information.* Evaluating and elucidating the significance, pertinence, and relevance of specific units of information on the basis of detailed analysis and subject competence.

15 *Scouting for Information.* Formal systems or specific programs for locating, gathering, and screening of unrecorded or newly recorded data and information from special sources such as personal contacts, conferences, meetings, government agencies, laboratories, clinics, and interviews.

16 *Transmitting and Copying.* Conveying and communicating units of data and information by manual, electronic, mechanical, and other means.

17 *Converting into Machinable Form.* Translating a unit of information into a symbolic form so as to be suitable for storage, identification and retrieval by mechanical or electronic instrumentation.

18 *Developing Information Systems.* Devising integrated plans for coordinating all elements of the information cycle in order to make materials available to all potential users in the most usable form with the least distortion of subject content.

19 *Investigating Machine Applications.* Developing systems, or adapting or exploring adequacy of existing systems, which utilize mechanical and electronic instrumentation to perform specific information functions in an integrated documentation or information system.

Characteristic library functions include the selection, acquisition, cataloging and classification of materials; bibliographic and readers' advisory services; reference and literature searching services; library management and systems planning; and the development and strengthening of library services. Such work is basically concerned with the collection, organization, preservation, retrieval, and use of recorded knowledge whether in printed, written, audiovisual, film, nearprint, magnetic tape, or other format.

Positions for librarians are found in various kinds of libraries and information facilities. Typical categories include the public library; the research library; the academic library; the special or technical library in business, industry, or government; and the educational media center, learning resources center, or school library.

Characteristic functions identified with information science are related not only to the traditional library functions but include specialized functions drawn from fields such as mathematics, logic, linguistics, psychlogy, computer technology, operations research, the graphic arts, communications, and management. Usually it is agreed that information science is concerned with the design and operation of systems for the collection, communication, storage, processing, and dissemination of information and with the technologies that support these functions. To some, information science is seen as virtually coextensive with library science; to others, the field is defined much more broadly to cover all information, in all forms, including measurement of data used in science; business data used in accounting, budgeting, marketing, or inventory control; social or economic data for health or government administration, etc. Information scientists may be concerned not only with operating information systems but with basic theory, with the social implications of the use of technology, and with government information policy in such diverse areas as copyright, privacy, and communications industry regulation.

Some information scientists work in information centers operated by industry or government, using automated systems to provide information on demand for users such as research scientists. Others may specialize in systems analysis and design or in computer programming, working in libraries, consulting firms, or in the growing industry devoted to producing and marketing information products. Many businesses and government agencies maintain specialized management information systems (MIS) requiring the services of people who can manage the collection, storage, and dissemination of information.

History

The School of Library and Information Science, founded in 1892, is the third oldest in the United States. It operates as a professional school within Drexel University for the education of librarians and information personnel and for the advancement of knowledge through study, research, and practice. From 1926 to 1949, it awarded the degree of Bachelor of Science in Library Science (B.S. in L.S.) to its graduates. The School now offers a curriculum leading to the Master's degree, which may be followed on a full-time or part-time basis in one of three major fields of concentration—general librarianship, information science, and educational media. Since September, 1974, the School has offered a program leading to the Ph.D. degree.

The Master of Science Curriculum

The School of Library and Information Science offers a program leading to the Master of Science degree with concentration in one of three fields: general librarianship, information science, and educational media. The degree is conferred on students who successfully complete an approved program consisting of a *minimum* of 48 quarter credits.

Prerequisite to all courses in the curriculum is *Fundamentals of Library and Information Science*, after which a student is able, through electives and individualized work, to specialize in one of the three major areas of concentration:

General Librarianship Information Science Educational Media

During the first quarter, or before completing *Fundamentals of Library and Information Science*, the student will decide on an area of concentration and will choose a faculty adviser who will assist him/her in developing a program of study appropriate to his/her background and his/her career goals.

Typically, a program of study in any of these areas of concentration will consist largley of courses chosen from five functional groupings of courses:

Organization and Retrieval of Information
Information Technology
Resources and Their Use
Information Services
Management and Evaluation

The balance of the program will consist of further electives which may include up to 12 credit hours chosen from Special Topics (L780), Independent Study (L893), Research (L897), Thesis (L898), and related graduate courses taken in other departments at Drexel or another area university.

Introductory Course

The program begins with Fundamentals of Library and Information Science, which is required of all students and is prerequisite to all other courses. It is offered on a full-time basis (L601-L602, 12 credits) in Summer and Fall terms and on a part-time basis in the Fall (L601, 6 credits) and Winter terms (L602, 6 credits).

In exceptional cases a student with a broad base of experience of a professional nature in library and information science, or with previous course work in library or information science, and with well defined educational goals and interests, may petition for exemption from L601-L602, *Fundamentals of Library and Information Science*. This petition should be made at the time of application to the School and should include a detailed statement of the applicant's reasons for seeking exemption and a description of the program the applicant proposes to follow at Drexel.

Information Science

Students who are qualified by background and interest to specialize in information science have the opportunity to develop a program of study which concentrates on ways in which information is collected, organized, indexed, stored, retrieved, interpreted, and transmitted to users. They will also be able to develop skill in research and in the use of computers to understand and devise better and more effective ways to handle information problems.

In addition to the required course, L601-L602, the student who concentrates in information science typically chooses the balance of his program from such courses as:

L605 Search Strategy

L607 Abstracting and Indexing

L620 Technology of Information Storage and Dissemination

L624 Library Automation

L626 Library and Information Networks

L627 Computer Programming for Information Processing

L628 Text Processing by Computer

L641 Resources in Science and Technology

L683 Information Center Management

L688 Information Systems Analysis

L690 Measuring Library Use

L691 Methods of Research in Library and Information Science

L692 Evaluation of Information Systems

Since information science is inherently multidisciplinary, there are many courses in other colleges at Drexel University that supplement the courses offered in the School of Library and Information Science. Among these are:

Management and Technology

Management of Information Systems

Management of Operating Systems

Systems Theory

Probabilistic Systems Analysis

Communication Behavior

Communication Systems

Detection and Decision Theory

System Simulation

Probabilistic Models for System Analysis

S UPPLEMENTARY
E MPIRICAL
T EACHING
U NITS IN
P OLITICAL
S CIENCE

Representation In The United States Congress: 1973

Developed by
RAY A. GEIGLE
California State College, Bakersfield

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Governors Commission
on Crime Prevention and
Control, State of Minnesota

Revised Edition: September, 1975

The authors wish to thank *Congressional Quarterly* for permission to use their variable, Presidential Support Score, and some of their interest group ratings. We also wish to thank the authors of the *Almanac of American Politics* from which we coded the Congressional district data and some of the interest group ratings.

The American Political Science Association
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Washington, D.C. 20036

The development of SETUPS, a series of learning materials on topics in American Politics, was supported by Grant GZ 3442 from the National Science Foundation to the American Political Science Association. This grant supported a College Faculty Workshop, hosted by the Inter-University Consortium for Political Research, at the University of Michigan, Summer, 1974.

The Workshop Project was administered by the Association's Division of Educational Affairs. The Workshop implemented a recommendation by the Task Force on Computer Related Instruction and approved by the Steering Committee on Undergraduate Education, to the effect that support should be sought to facilitate the development of learning materials that involve political science students actively in inquiry.

Test editions of SETUPS were prepared by the faculty participating in the workshop. (Seven of these test editions were prepared and distributed initially by the ICPR project staff.) Each SETUPS was reviewed by at least three qualified persons and tested in at least six classes. These evaluations were used by the authors and the editor in revising the modules.

The revised editions of SETUPS are published under the auspices of the Division of Educational Affairs. However, the views expressed are those of the authors and not of the Division of Educational Affairs or of the American Political Science Association.

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FOREWORD

Throughout its history, the American Political Science Association has been interested in teaching. A standing committee on teaching political science was appointed at the first organizational meeting of the APSA in 1903. At the second meeting of the newly formed association in 1905, the principal report delivered to the members was on a survey of college freshmen, conducted by William Schaper of the University of Minnesota, called "What Do Our Students Know About American Government Before Taking College Courses in Political Science?" Since then, APSA has been almost continuously engaged in one or more activities designed to assist teachers. These early activities are summarized in a 1963 report on the history of Association education activities by Cora Prifold (Beebe). In all of this activity, the Association has been concerned that its efforts not establish an orthodoxy, a preferred method or approach. It has and does seek to aid teachers with diverse interests, fields and techniques.

SETUPS is another in the long list of efforts to aid teachers. The Association's role in their production and distribution grows out of the recommendations of a task force on computer related instruction, established in February, 1973, which reported to the Steering Committee on Undergraduate Education in January, 1974. The latter committee agreed that there was a need for special learning materials for data analysis exercises and simulations.

At this point, APSA was fortunate in receiving a grant from the National Science Foundation's College Faculty Workshop Program that enabled DEA to develop the SETUPS with cooperation of the Inter-University Consortium for Political Research. A workshop was held, at the University of Michigan, Betty Nesvold and William Buchanan serving as coordinators.

We owe a debt of appreciation to the individual authors who were ultimately responsible for the written materials and to the schools that participated in the testing program. After testing, each booklet was revised for publication.

It is the hope of those who have participated in the project that the materials will prove of value to many teachers. It also is hoped that the Association will be able to continue to meet these needs while at the same time aiding in the development of other projects to assist teachers in other areas of the discipline having different theoretical and pedagogical perspectives.

Evron M. Kirkpatrick
Executive Director
American Political Science Association
September, 1975

EDITOR'S PREFACE

Supplementary Empirical Teaching Units in Political Science are modules for teaching American government. Their function is to stimulate students to independent, critical thinking, to convey a deeper understanding of portions of the substantive content of the course, and to demonstrate how scholars accumulate the evidence and reach the conclusions that appear in their textbooks. They enable students to make use of the computer with no previous training, either to analyze data on political behavior or to see the consequences of policy decisions by use of a simulation model.

They were developed by a group of political scientists with experience in teaching the introductory American Government course who were brought together in a workshop supported by a grant from the National Science Foundation in the summer of 1974. The American Political Science Association administered the grant, and the Interuniversity Consortium for Political Research was host to the workshop and provided data for most of the SETUPS. Seven modules were then tested during the 1974-75 academic year in 155 classes in 69 universities and colleges, and evaluated by their students and faculty. The revised editions were based upon this experience. Additional SETUPS in American Government, International Relations and Comparative Government are now in process of development.

Participants in the 1974 workshop were Christopher Arterton, Massachusetts Institute of Technology, Paul Allen Beck, University of Pittsburgh, Bruce D. Bowen, University of Michigan, C. Anthony Broh, Hobart & William Smith Colleges, Jere W. Burner, Oberlin College, Donald A. Dixon, California State College, Sonoma, L. Douglas Dobson, Northern Illinois University, Ray A. Geigle, California State College, Bakersfield, Harlan Hahn, University of Southern California, Peter G. Hartjens, Franklin and Marshall College, Marvin K. Hoffman, Appalachian State University, Barry Hughes, Case Western Reserve University, Charles L. Prysby, University of North Carolina, Greensboro, John Paul Ryan, Vassar College and C. Neal Tate, North Texas State University. Workshop directors were William Buchanan, Washington and Lee University, and Betty A. Nesvold, San Diego State University. Project directors were Lutz Erbring, Interuniversity Consortium for Political Research, University of Michigan and Sheilah Koeppen, Division of Educational Affairs, American Political Science Association.

In this SETUPS module, classical theories of representation as expressed by Burke and the founding fathers and developed by modern political philosophers serve as a foundation for propositions about the behavior of U.S. Congressmen and Senators in the 1970's. Constituency characteristics such as urbanism, occupation and ethnicity, electoral competition and party affiliation, ratings by a variety of interest groups, and presidential influence provide variables for crosstabulations in which the student tests theories of representation. These variables and roll call votes on 11 major issues in the 93rd Congress are coded in simplified form to eliminate problems of data manipulation. A series of exercises explains the process and purpose of hypothesis testing with bivariate tables and the function of controls. These exercises are designed for the introductory American Government course, but the data set is comprehensive enough to derive relatively sophisticated problems for advanced classes in legislative behavior or research methods.

A "Note to the Instructor" in the Appendix provides suggestions for classroom use.

William Buchanan
Editor

SETUPS: American Politics

The SETUPS in this series were designed for use in introductory classes in American Government. During the testing period they were widely used in these courses and were also found helpful in advanced classes. Data in the form of OSIRIS, SPSS or card image form for all SETUPS is provided by the Inter-University Consortium for Political Research, University of Michigan, without charge through an agreement with the American Political Science Association, for each order of 25 or more SETUPS.

SETUPS in the American Politics series are:

VOTING BEHAVIOR: The 1972 ELECTION by Bruce D. Bowen, C. Anthony Broh, Charles L. Prysby.
POLITICAL SOCIALIZATION ACROSS THE GENERATIONS by Paul Allen Beck, Jere W. Bruner, L. Douglas Dobson
POLITICAL PARTICIPATION by F. Christopher Arterton, Harlan Hahn
REPRESENTATION IN THE UNITED STATES CONGRESS: 1973 by Ray A. Geigle and Peter J. Haridakis
THE SUPREME COURT IN AMERICAN POLITICS: POLICY THROUGH LAW by John Paul Ryan, C. Neal Tate
U.S. ENERGY, ENVIRONMENT AND ECONOMIC PROBLEMS: A PUBLIC POLICY SIMULATION by Barry Hughes
THE DYNAMICS OF POLITICAL BUDGETING: A PUBLIC POLICY SIMULATION by Marvin K. Hoffman.

A second series of SETUPS, on topics in Comparative Politics, is being developed and tested in 1975-1976.

I. INTRODUCTION

This is a monograph about constituency representation in the United States Congress that is designed to get you involved in the processes of inquiry that are often used by political scientists to investigate this concept. Our objectives for you are three: (1) that you will familiarize yourself with three different theories of what representation *ought to be*, and some of the current research findings of political scientists about what representation is actually like, (2) that you will develop sufficient skill in some elementary techniques of political inquiry to investigate your own ideas about the *nature of representation* in Congress, and (3) that you will do inquiry of your own, using data sets prepared for use with the exercises in this manual and evaluate your findings in terms of the information you have gained by accomplishing the first objective. The manual is organized in four sections. The first is a brief overview of some theories of representation and some current research findings about representation in Congress. The second is an introduction to and exercises in hypothesis testing (the technique used by political scientists to investigate political phenomena) that will provide you with sufficient skills to conduct your own inquiry. The third is a description of the evidence (data) you will use to test your ideas about the nature of constituency representation in Congress. It is composed of aggregate measures of constituency characteristics (income, education, etc.) of the populations within each of the 435 Congressional districts and 50 states, the ratings of Congressmen by interest groups, and roll call votes of members of Congress on a selected list of issues. The fourth section is a set of exercises that are self-programmed. These will facilitate your investigation of your own ideas about representation.

The Theories of Representation

A mainstay of our understanding and acceptance of democratic government is the widely accepted notion that our political institutions ought to be, and in most cases are, *representative*. We accept the common sense notion that because of bigness and complexity direct democracy, that is, government by participation of all, is impractical and that republican government, government by representatives, is an agreeable alternative. It is clear that the Founding Fathers intended that our political institutions be representative and that many of our present assessments of the quality of our institutions are based upon the degree to which they accomplish that objective. Thomas Jefferson's view was that republican government is

necessary for purposes of both administrative expediency and competent government. In a letter to a friend, Pierre Samuel Dupont de Nemours, Jefferson outlined his view on this question in 1816. In it he said, "We of the United States, you know, are constitutionally and conscientiously democrats. We consider society as one of the natural wants with which man has been created; that he has been endowed with faculties and qualities to effect its satisfaction by concurrence of others having the same want; that when, by the exercise of these faculties, he has procured a state of society, it is one of his acquisitions which he has a right to regulate and control, jointly indeed with all those who have concurred in the procurement, whom he cannot exclude from its use or direction more than they him. We think experience has proved it safer, for the mass of individuals composing the society, to reserve to themselves personally the exercise of all rightful powers to which they are competent, and to DELEGATE those to which they are not competent to deputies named, and removable for unfaithful conduct by themselves immediately. Hence, with us, the people (by which is meant the mass of individuals composing the society) being competent to judge of the facts occurring in ordinary life, they have retained the functions of jurors; but being unqualified for the management of affairs requiring intelligence above the common level, yet competent judges of human character, *they chose, for their management, representatives*, some by themselves immediately, others by electors chosen by themselves . . . ." He believed that "action by the citizens in person, in affairs within their reach and competence, and in all others by representatives, chosen immediately and removable by themselves, constitutes the essence of a republic."[1]

The predominant view in the Constitutional Convention was also in favor of republican government. James Madison, writing to the people of the state of New York in support of ratification of the Constitution, argued that, "we may define a republic to be, or at least may bestow that name on, a government which derives all its powers directly or indirectly from the great body of the people, and is administered by persons holding their offices during pleasure, for a limited period, or during good behavior."[2] Madison continued, in the 39th Federalist, to detail the aspects of the proposed government that give it its republican character. First on his list was the House of Representatives, chosen by direct election of "the great body of the people," and the Senate which "derives its appointment indirectly from the people." (Until the adoption of the XVII Amendment to the Constitution in 1913, Senators were elected by state legislatures.)

The view of both Madison and Jefferson are characteristic of the theoretical underpinnings of our governmental institutions and of the intent of the Constitution. Agreement about the desirability of representative institutions, however, did not lead to consensus about who ought to be represented and how. The Madisonian notion that man is by nature inclined to seek out others who are of like disposition on questions of government and that once aggregated they will form "factions" that will pursue their collective interests to the detriment of those in other "factions," led him to the general view that representative institutions ought to be a mechanism for the deflection and amelioration of the "evils of faction."[3] He thought that the evils of faction could only be cured by removing its causes or controlling its effects. He strongly opposed *eliminating* factions because the cost would have included the sacrifice of human liberty, dignity and diversity, the protection of which is the first object of government. He proposed, therefore, to *control its effects* by bringing antagonists together where, because of the diversity of issues and human interests, no faction will ever comprise a majority and dominate all other interests. Economic differences are largely responsible, in Madison's view, for dividing men "into different classes, actuated by different sentiments and views."[4] He concludes that "the regulation of these various and interfering interests forms the principal task of modern Legislation, and involves the spirit of party and faction in the necessary and ordinary operations of Government."[5] In summary, the Madisonian notion of representation tended to emphasize the importance of control of factions and their "mischief" in the legislative process.

Hamilton's view of representation was similar to that of the great English political philosopher, Edmund Burke. Hamilton believed that where elections are "free, representative institutions will invariably be made up of landholders, merchants, and men of the learned professions." Of the three, only the latter could be expected to protect the interests of all classes because of their superior wisdom and common interest. He thought that "the idea of an actual representation of all classes of the people by persons of each class is altogether visionary."[6] But he was nevertheless committed to the notion of *popular* control of the conduct of representatives. A careful delineation of his views will facilitate understanding of often misconceived notions of Hamilton's genuine views. Like Edmund Burke he believed in the desirability of men of superior talent and wisdom making legislative decisions they determined to be in the *interest* of the people they represent, even when that behavior conflicted with expressed wishes of those whom they represent. The case for this position was made eloquently by Burke in an address in 1774 to his constituents in which he said:

> Certainly, Gentlemen, it ought to be the happiness and glory of a representative to live in the strictest union, the closest correspondence, and the most unreserved communication with his constituents. Their wishes ought to have great weight with him; their opinions high respect; their business unremitted attention. It is his duty to sacrifice his repose, his pleasure, his

[1] Kenneth M. Dolbeare, *Directions in American Political Thought* (New York: John Wiley & Sons, Inc. 1969), pp. 77-78.
[2] *The Federalist*, No. 39, Edited and With an Introduction and Notes, by Jacob E. Cooke (Middletown, Conn.: Wesleyan University Press, 1961), pp. 250-257.

[3] *The Federalist*, No. 10, op. cit., pp. 56-65.
[4] A.J. Beitzinger, *A History of American Political Thought* (New York: Dodd, Mead & Company, 1972), p. 222.
[5] *The Federalist*, No. 10, op. cit.
[6] Beitzinger, op. cit., p. 224.

his view party influences are two-fold: the first, a persistent socialized policy orientation that the member of Congress brings with him, the second, a "broad class of party influence (that) includes those instances in which a member of Congress seeks out, or accepts, the counsel of another person in arriving at a policy decision because the other person is a fellow partisan."[20] These cues are sought and given at all stages in the decisional process and are both formal and informal. Congressmen talk together, with group spokesmen, their staffs, and party leaders. As they cover a wide range of policy and issue areas in their discussions and deliberations, they reinforce and stimulate each other's views and work towards some degree of agreement. This process of "cue" taking and giving is clearly a part of the process and is reported in most research on the Congress. The extent to which it genuinely creates agreement is difficult to say and perhaps impossible to investigate. It is, however, an additional possible explanation of party cohesion in voting.

To summarize here, party cohesion is an empirically verified characteristic of Congressional roll-call voting. There is variation by issue and policy area but party similarity has been a better predictor of Congressional voting patterns over time than any other single variable. When party similarity has not explained voting patterns, the next most reliable indicator has been the constituency characteristics of the members of Congress. At least one observer, Fromen, believes that similarities in party voting may be just an additional measure of constituency influence. The notion that party regularity is policed by an effective party leadership does not seem to be supported by the evidence. The process of cue-taking, the exchange of information and views among Congressmen, their staffs, etc., is another possible explanation of party regularity but one that is difficult to demonstrate conclusively.

Questions about whether constituency representation in Congress is achieved through any of the processes described above have profound implications for our notions about democracy. Part of our determination of what representation ought to be like will invariably be a function of what representation is actually like. If you believe that we can be represented if Congressmen ascertain our probable preferences by consideration of the predominant characteristics of our districts, then you can gather evidence about constituency characteristics of the 435 districts and 50 states and compare the voting records of members of Congress with their own districts or states. In short, you will be using evidence to determine if representation is actually anything like you think it ought to be.

In the exercises in the fourth section of this manual you will be asked to do this using the techniques of investigation commonly used in political science. That is, you will look at evidence systematically and use empirical methods of analysis to test assertions about the representativeness of members of Congress in their voting decisions. The second section will introduce you to these techniques.

[20] Clausen, op. cit., p. 123.

II. METHODS

One of the goals of social scientists is to explain how social phenomena come to be. And while the language of social science often seems foreign to students, the thought processes involved are ones that we all use daily. When the President makes a trip to the Middle East or the Soviet Union we say it *influences* both our relations with those countries and his popularity ratings at home. When a football team has a good season, we say that is a *result of* good recruiting and hard practice. Long, thoughtful study is *associated with* good grades. When we make such statements we are thinking like social scientists.

The social scientist is concerned with testing common sense notions about reality, and to do this he must be concerned with both the *procedures of inquiry* and the precise use of language.

In order to understand each other, social scientists have more or less agreed on the *terms* they use in describing their procedures. You should be familiar with some of these terms so that you will have a common basis for discussing and evaluating the exercises in this book.

When we posited above that something was "influenced by" or "the result of" or "associated with" something else, we were just setting up an *hypothesis* that we could then test.

A good way to think of hypotheses is in terms of change or differences. If something changes, *then* it may be associated with a change in something else. Or if we look at differences in one thing, then we would expect to find related differences in some other thing. But what are these "things" that we keep talking about? If a phenomenon appears in different forms or takes on different values then we refer to it as a *variable*. An hypothesis, then, is *a statement that posits a relationship between two or more variables*.

There is often a temptation when formulating hypotheses to say that a change in one variable *causes* a change in another variable. This is a temptation which should be avoided! Would you be correct in stating that the President's taking a trip causes a change in our relations with the countries visited? Perhaps, but we really have no way of knowing whether it was the trip *per se* which brought about the change or whether it was the months of negotiations which preceded the trip or the desire of those countries for more American technology which really caused the change in our relations.

It is because of the difficulties in attributing causality that social scientists prefer to err on the side of caution and talk about variables being

associated or *related* rather than one causing the other. You should try to get in the same habit yourself, not only because you should want to be cautious, but also because you should constantly be asking yourself the question "Is there anything else which might affect the relationship I have hypothesized?" It is through this constant questioning that a sound body of understanding of political phenomena is developed.

There are two types of variables that we use in formulating hypotheses. The variable in which we expect some change to be produced is called the *dependent* variable. In the example above, the *relations* with the countries the President visits would be the dependent variable. Why? Well, if you think about it, this is really common sense. We are hypothesizing that a change in our foreign relations is *dependent* upon something else—the President taking a trip. You would not say, however, that the President's taking a trip was dependent upon a change in our foreign relations with these countries since we expect the change to come after the trip. The trip itself then is *independent* of changes in our relationship with the countries visited. A variable which we hypothesize as being associated with a change in some dependent variable is referred to as an *independent variable*. Why? Because change in it can take place independently of change in the dependent variable.

One of the most common ways of testing hypotheses is to gather data that can be grouped into categories and then to interrelate two variables in a table.

Let's take an example from the data you will be using later on.

In 1973, the Congress passed legislation that limited the war-making powers of the President. This legislation was vetoed by President Nixon. Subsequently both houses of Congress achieved the necessary two thirds majority to override the veto. The question we would like answered is, "To what extent was the vote to override in the House of Representatives cast along partisan lines?" On an issue such as a presidential veto override, we would hypothesize that Democrats would unite against the President and that Republicans would rally to defend the President's position. In other words, we are hypothesizing that a congressman's *party* (independent variable) will influence how he will vote on this issue (dependent variable). To test this hypothesis, we will divide the members of the House by party and by their vote on this issue. When we do this, we obtain the following table.

		PARTY DEMOCRAT	REPUBLICAN	
VOTE	YEA	198	86	284
	NAY	34	101	135
		232	187	419

There are four *cells* in this table and each includes the number of persons of a party who voted in a certain way. These numbers are known as *cell*

frequencies. Thus there were 198 Democrats who voted to override the veto and 101 Republicans who voted against overriding the veto. The numbers at the bottom and side of the table are known as *marginals*. In this case, the marginals on the bottom will tell you how many Democrats and how many Republicans participated in the vote. The marginals on the side will tell you the division of the vote—the total number of yea votes and the total number of nay votes. The figure in the lower right hand corner of the table is the sum of *row marginals* and also the sum of the *column marginals*. In this case a total of 419 Democrats and Republicans voted (or paired their votes) on the issue of overriding the President's veto. Sixteen members neither voted nor paired their votes on this issue. You should try to get in the habit of examining both the cell frequencies and the marginals of each table for evidence about your hypothesis.

To examine our hypothesis more clearly, however we need to know not only the number (or frequency) of Democrats and Republicans who voted yea or nay, but also the proportion (or percentage) of the members of each party who voted each way.

Most computers generate tables that report both frequencies and percentages. To do this, however, the computer must be instructed as to which is the independent and which is the dependent variable. The convention accepted by most social scientists is to place the independent variable across the top of the table (the columns) and the dependent variable along the side (the rows). One then calculates the percentages down the columns. In reading the cells of a percentage table, the question you should ask is, "What percentage of X (a category of the independent variable) did Y (a category of the dependent variable)?"

		Independent Variable PARTY DEMOCRAT	REPUBLICAN	
Dependent Variable VOTE	YEA	198 85.3	86 46.0	284 67.8
	NAY	34 14.7	101 54.0	135 32.2
		232 55.4	187 44.6	419 100.0

Answer the following questions about the cells and marginals of the above table.

1. What percentage of the Democrats cast Yea votes? ____
2. What percentage of the Republicans cast Nay votes? ____
3. What percentage of all the votes were cast by Democrats? ____
4. What percentage of the total votes were Yea votes? ____

5. Write a brief paragraph describing what this table tells you about the hypothesis.

Now let's consider an example in which we have divided the data for one variable into more than two categories. In this case, we will be examining the relationship between the median income of citizens in a member's district and his or her vote on an appropriations bill for the departments of Labor and Health, Education and Welfare. Since the vote was on a compromise bill between the House and Senate which would have reduced monies available to these agencies, many liberals opposed this legislation because they felt it did not provide enough support for programs in these areas. Before looking at the table that follows, what would you expect the relationship between income and vote on this measure to be? Would you expect opposition to the compromise to come from the representatives from the wealthier or the poorer districts? Justify your expectations and then state your hypothesis.

When a variable is divided into three or more categories ranging from low to high (or high to low), social scientists refer to the data as being arrayed along a dimension. In our first example we asked, "Did Democrats vote differently than Republicans?" When we have more than two categories, we have to ask a slightly different question, namely "As income increases, does the tendency to vote Yea or Nay change?" If we have hypothesized a direction of change, we would look for a change in the proportion of votes cast Yea or Nay as we moved from the lowest to the highest category of our independent variable. While this sounds somewhat difficult, all we are really saying is that you should not only look at the lowest and highest categories of each variable, but should also be concerned with the *pattern of change* in the intermediate categories.

Examine the table below and describe the extent to which you feel your hypothesis has been confirmed.

		MEDIAN INCOME			
		$5,000-$8,999	$9,000-$10,999	$11,000-$17,999	
VOTE	YEA	100 75.2	102 65.8	72 52.6	274 64.5
	NAY	33 24.8	53 34.2	65 47.4	151 35.5
		133 31.3	155 36.5	137 32.2	425 100.0

1. Are increases in income associated with the changes in vote that you expected?

2. Would you characterize the impact of income on this vote as being a clear (or a strong) one? Why do you feel that way?

3. How would you describe the pattern of change that you have observed?

4. What do the marginals tell you about the variables you are relating?

What we have been doing up to this point is examining the impact of two variables (party and median income) on two different votes in the House of Representatives. This is known as *bivariate* analysis—the relationship between one independent and one dependent variable.

Very often, however, we wish to examine more than two variables at one time. We often want to examine the relationship between two variables while holding some third variable *constant*. When we hold something constant, all we are really doing is hypothesizing that the relationship between an independent and a dependent variable will be different for different categories of some third variable. Let's go back to our hypothesis that the President's trip will affect our foreign relations with the countries visited. You will recall that we said it was difficult to determine whether changes we observed were really due to the President's trip or to long negotiations that preceded the trip. To test this possibility we could introduce the concept of control into our analysis.

We could, for example, divide the countries that the President has visited into two categories—those where extended negotiations preceded the trip and those where they did not. We could then examine the relationship between a trip and changes in our foreign relations for each of these groups. If we found a different relationship for the two groups we could argue that the holding of negotiations (the control variable) has an effect on the relationship between the President's trip and changes in the foreign relations of the United States.

In the table just analyzed you discovered a relationship between median income and the vote of Congressmen on the Labor-HEW appropriations compromise.

Let us now raise a question for further examination. Would you expect that income differences would affect Democrats and Republicans alike? Or, alternatively, would you expect pressures other than income to be more influential for the members of one party? State your expectations below.

To examine this question, we can divide the members of the House into Democrats and Republicans and examine the relationship between median income and vote for each group. Our hypothesis for this analysis will read as follows, "When we control for the impact of party (control variable), we will find that median income has a different impact on the vote on this issue for Democrats than for Republicans." Let us now take a look at the two tables with which we can test this hypothesis. The first table shows the relationship between median income and the vote for Democrats, the second the relationship for Republicans.

DEMOCRATS

		MEDIAN INCOME $5,000-$8,999	$9,000-$10,999	$11,000-$17,999	
VOTE	YEA	80 65.9	37 42.0	11 17.5	108 44.6
	NAY	31 34.1	51 58.0	52 82.5	134 55.4
		91 37.8	88 36.4	63 26.0	242 100.0

REPUBLICANS

		MEDIAN INCOME $5,000-$8,999	$9,000-$10,999	$11,000-$17,999	
VOTE	YEA	40 95.2	65 97.0	61 82.4	166 90.7
	NAY	2 4.8	2 3.0	13 17.6	17 9.3
		42 23.0	67 36.6	74 40.4	183 100.00

Write a brief analysis of these two tables. To what extent do the results tend to confirm the hypothesis? To what do you attribute the differences you have discovered in the relationship between median income and vote on this issue for Democrats and the relationship for Republicans?

SUMMARY OF TERMS AND TECHNIQUES

In this section, we have introduced you to some of the common language used by political scientists in the testing of hypotheses. Before going on to the analyses in the next section, you should be certain that you understand these terms. If you have had difficulty in understanding any of the following terms, you should ask your instructor to clarify them.

1. hypothesis:
2. variable:
3. independent variable:
4. dependent variable:
5. table cells:
6. cell frequencies:
7. marginals:
8. dimension:
9. pattern of change:
10. bivariate analysis
11. control:

III. DESCRIPTION OF DATA

Now that you have some familiarity with the research methods commonly used by political scientists in bivariate analysis you are ready to apply them to evidence concerning our questions about representation. Evidence that is systematically gathered and ordered in a manner that it can be used to investigate hypotheses is usually referred to as *data*. The nature of the data necessary to test hypothesis, quite naturally, depends on the nature of the problem you are working with. As we are trying to answer questions about the voting behavior of members of Congress and the possible association with the characteristics of the constituencies they represent, we need data that include a record of how each member of Congress voted on a few pieces of legislation and description of the constituencies of each member of Congress.

The data we actually use to test hypotheses are always determined by the judgment of the researchers about what is needed, and the available resources to gather them. These two factors often impose serious limitations on the conclusions we can justifiably reach through our research efforts. Sometimes the evidence we gather does not help us answer our research questions because we have made a bad guess about the specific evidence we need or used bad judgment in the methods we used for gathering it. Often we are so limited by the resources available to gather the evidence that we must accept either data that have been gathered by someone else or that we can gather inexpensively ourselves. As a result of these two limitations our findings are always regarded as tentative until they are corroborated; findings are often invalidated by newer or better evidence, alternative research methodologies, etc. Thus the conclusions you reach in these exercises are always dependent upon the data used and consequently should be regarded with scholarly caution.

The data you will use in these exercises are in four general categories: 1) data that describe the 435 Congressional districts and the fifty states that were chosen by the authors from information made available to the public by the U.S. Census Bureau, 2) the age, seniority, and party of each member, 3) ratings of each member of Congress by selected interest groups, and 4) data about important House and Senate votes from the first session of the 93rd Congress (1973). The data provided here include: (by variable name as they are listed in the codebook)

(1) **REGION**—This variable is of grouping of states according to geographical location in the country. They are grouped according to the

standard ICPR codes so that they will be consistent with similar research done elsewhere. The region names and the states within each region are:

0. *New England*—Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
1. *Middle Atlantic*—Delaware, New Jersey, New York, Pennsylvania
2. *East-North Central*—Illinois, Indiana, Michigan, Ohio, Wisconsin
3. *West-North Central*—Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
4. *Solid South*—Virginia, Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas
5. *Border States*—Kentucky, Maryland, Oklahoma, Tennessee, West Virginia
6. *Mountain States*—Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
7. *Pacific States*—California, Oregon, Washington
8. *External States*—Alaska, Hawaii

(2) SOUTH-NON-SOUTH—This variable groups states into two classifications: those in the "deep South" (2), and all the remaining states in the union (1). The South-Non-South division is included because of the hypothesized persistence of "block" voting of southern Senators and Congressmen in the literature on the Congress.

(3) URBAN-RURAL INDEX—Census data were used to create five categories of dominant residential types into which the House districts were classified. Three categories, *urban*, *suburban*, and *rural* are pure types in which at least 60% of the district population resides in one of the three residential categories. In the *urban* category 60% or more of the population resides in SMSA (Census Bureau Standard Metropolitan Statistical Area) central cities of 50,000 people or more. In the *suburban* category 60% or more of the population resides in central city suburbs within the SMSA district. In the *rural* category 60% or more of the population resides outside SMSA central cities and suburbs. Two additional categories, *urban-suburban*, and *suburban-rural* are mixed types in which no single category contains more than 60% of the population but in which urban-suburban percentages are greater than suburban-rural in the earlier category and less in the latter. Census data were used to create three categories of dominant residential types ranging from the most urban (1) to the most rural (3) states, for the Senate data.

(4) MEDIAN INCOME—Census Bureau figures for median income were divided into three income categories.

1 = $5,000-$8,999
2 = $9,000-$10,999
3 = $11,000-$17,999

Approximately one third of the districts and states fell into each category.

(5) PERCENT WITH INCOME OVER $15,000—Census Bureau figures for the percent of family incomes over $15,000 in each district and state. Four categories were created ranging from lowest to highest percentage. In the House they are:

1 = 5 - 14%
2 = 15 - 22%
3 = 23 - 34%
4 = 35 - 58%

In the Senate they are:

1 = 0 - 12%
2 = 13 - 17%
3 = 18 - 22%
4 = 23 - 36%

(6) PERCENT WITH INCOMES UNDER $3,000—Census Bureau figures for the percent of family incomes under $3,000 in each district and state. Four categories were created ranging from lowest to highest percentage. In the House they are:

1 = 0 - 7%
2 = 8 - 11%
3 = 12 - 17%
4 = 18 - 33%

In the Senate they are:

1 = 0 - 7%
2 = 8 - 10%
3 = 11 - 13%
4 = 14 - 25%

(7) MEDIAN YEARS OF SCHOOL—Census Bureau figures for median years of education of all persons in the state or district over twenty-five years of age. Four categories were created ranging from fewest to most median years of education in each of the districts and states. In the House they are:

1 = 8 - 10
2 = 11
3 = 12
4 = 13

In the Senate they are:

1 = 10
2 = 11
3 = 12
4 = 13

(8) PERCENT WITH WHITE COLLAR JOBS—Census Bureau figures for the percentage of white collar workers in each congressional district and state. Three categories were created ranging from lowest to highest percentage with approximately one third of the districts or states in each category. In the House they are:

1 = 30 - 42%
2 = 43 - 50%
3 = 51 - 79%

In the Senate they are:
1 = 37 - 44%
2 = 45 - 49%
3 = 50 - 56%

(9) PERCENT WITH BLUE COLLAR JOBS—Census Bureau figures for the percentage of blue collar workers in each congressional district and state. Three categories were created ranging from lowest to highest percentage with approximately one third of the districts or states in each category. In *both* the House and the Senate they are:
1 = 10 - 32%
2 = 33 - 39%
3 = 40 - 59%

(10) PERCENT WITH SERVICE JOBS—Census Bureau figures for the percentage of service occupations in each congressional district and each state. Three categories were created ranging from lowest to highest percentage with approximately one third of the districts or states in each category. In the House they are:
1 = 6 - 11%
2 = 12 - 13%
3 = 14 - 25%
In the Senate they are:
1 = 6 - 12%
2 = 13%
3 = 14 - 25%

(11) PERCENT FARMERS—Census Bureau figures for the percentages of farm workers in each congressional district and state. Three categories were created ranging from lowest to highest percentage. In the House they are:
1 = 0%
2 = 1 - 5%
3 = 6 - 24%
In the Senate they are:
1 = 0 - 2%
2 = 3 - 4%
3 = 5 - 22%

(12) PERCENT BLACK—Census Bureau figures for the percentage of total population of black people in Congressional districts and states. Four categories were created in the House and three in the Senate ranging from lowest to highest percentage of black population. In the House they are:
1 = 0 - 5%
2 = 6 - 20%
3 = 21 - 47%
4 = 89%
In the Senate they are:
1 = 0 - 5%
2 = 6 - 16%
3 = 17 - 37%

(13) PERCENT SPANISH-AMERICAN—Census Bureau figures for the percentage of Spanish-American people in each congressional district and in each state. Four categories were created in the House and three in the Senate ranging from lowest to highest percentage of Spanish-American population. In the House they are:
1 = 0 - 5%
2 = 6 - 20%
3 = 21 - 39%
4 = 40 - 75%
In the Senate they are:
1 = 0 - 2%
2 = 3 - 7%
3 = 8 - 40%

(14) PERCENT FOREIGN STOCK—Census Bureau figures for the percentage of persons who were born or whose parents were born in a foreign country in each of the congressional districts and states. Four categories were created in the House and three in the Senate ranging from lowest to highest percentage of foreign stock. In the House they are:
1 = 0 - 10%
2 = 11 - 20%
3 = 21 - 39%
4 = 40 - 60%
In the Senate they are:
1 = 0 - 10%
2 = 11 - 17%
3 = 18 - 33%

(15) PARTY—Party membership of members of the House and Senate. The two Senators who are not members of the major parties have been listed as members of the parties with which they caucus. Senator Buckley (Conservative, New York) has been listed as a Republican and Senator Byrd (Independent, Virginia) has been listed as a Democrat.
1 = Democrat
2 = Republican

(16) COMPETITIVENESS INDEX—A measure of the relative competiveness of electoral contests in each of the districts and for each of the Senators. The degree of competition is determined by the percentage size of the victory of the incumbent (in his/her most recent election) over the closest opponent. The percentage (of the combined Republican and Democratic vote) won by the incumbent is the specific index of the degree of competitiveness of the districts or states and is the basis for the rankings. Three categories were created for both Senators and members of the House that ranked them from least to most competitive. (1) *MOST COMPETITIVE*—Senators and Congressmen who captured 50-57% of the combined Democratic and Republican vote (2) *MODERATELY COMPETITIVE*—Senators and Congressmen who captured 58-67% of the combined Democratic and Republican vote (3) *SAFE*—Senators and

affirmative vote was to grant the powers to the President with the limitations specified above. The vote was yea 230, nay 147 (240 to 157 including pairs).

(36) AUTO EMISSION STANDARDS—The vote was on an amendment, proposed by Congressman Wyman, to an emergency energy bill that would have postponed auto emission controls until January 1, 1977. (HR 11450) The amendment was proposed as a partial and short term solution to problems created by the energy shortage. Under the proposal controls would not have been postponed in serious pollution areas like New York and Los Angeles. A negative vote would have been to kill the bill and maintain early implementation of the emission controls. The vote was yea 180, nay 210 (there were no pairings on this vote).

(37) SCHOOL BUSING—The vote was on an amendment to the Elementary and Secondary Education Act (HR 69) to prevent busing of children for purposes of desegregation to any but the school closest or next closest to the student's home. The language of the bill did not include the provision provided by the Senate for ultimate court responsibility in matters of busing. In an unusual move the House voted to instruct its members of the conference committee working out a compromise with the Senate to reject any other than its language in the bill. An affirmative vote would have been to prevent busing as specified above. The vote was yea 293, nay 117 (there were no paired votes).

IV. EXERCISE NUMBER ONE

The purpose of this exercise is to involve you in the process of testing the assertion that knowledge of the urban-rural mix of a Congressman's constituency will help explain his vote on selected issues. We expect, based on informed guessing, that legislators from highly urban districts are more likely to vote in agreement with each other on certain issues than on others. They are also more likely to vote in disagreement with legislators from predominantly rural districts on those same issues. For example, it seems more reasonable that legislators from urban districts will support rapid transit funding for municipalities by the federal government than it does that legislators representing rural constituencies will. It also seems more likely that legislators from rural districts will support legislation raising price supports for feed grains than it does that legislators from predominantly urban districts will. Both of these assertions are based upon our informed guesses about what seems most reasonable. Even though they are *informed* guesses and they seem *very reasonable*, they are still guesses that can be verified or rejected only by looking at actual voting records of members of Congress from each type of district.

Our informed guesses are based on research done by others and our assessment of reasonable conclusions that might be drawn from those of their findings that have implications for the problems that interest us. For example, those attributes of urban life that distinguish it from rural life, that have been documented by researchers, are useful guides to guessing about political differences that may follow. Urban life is distinguished from rural life in the kinds of life experiences people undergo in each environment and the kinds of problems they have. Urban life, in general, is more crowded, more complex, and more hurried than rural life. Peoples' occupations, their avocations, and even their vacation and recreational opportunities vary substantially from urban to rural areas. As a result of the differences in types of life styles, the expectations, values, and beliefs of urban people are likely to be different from those who live in a rural setting. Unique characteristics associated with urban life have to do with crowding (or overcrowding) of people and the resultant problems of housing, mass transit, unemployment, poverty, racial tension, institutional conflict, and so forth.

In doing this exercise you will use information about urban-rural differences to make an informed guess about how they might affect the way legislators vote on a few selected issues. After having made the guess,

you will then want to test your perspicacity and see if the evidence tends to verify or refute it. The method you will use to do that is the one with which you now have some familiarity, hypothesis testing through bi-variate tabular analysis.

Relax! That only means that you will write your guess in hypothesis form, ask the computer to compare your variables, write the results in the cells of a table so that they can be easily read, and analyze them.

STEP NUMBER ONE—Write Two Hypotheses

In this part of the exercise you are to write two hypotheses using the independent variable, *urban-rural index* (described in detail in the description of data section) and two dependent variables chosen for you by your instructor. The dependent variables are the votes of each of the 435 members of the House of Representatives on two pieces of legislation from the first session of the 93rd Congress.

Hypothesis Number 1 _____

_____

_____

Hypothesis Number 2 _____

_____

_____

What relationship do you expect to find between the two variables in each of these hypotheses? Why?

Hypothesis Number 1 _____

_____

_____

_____

Hypothesis No. 2 _____

_____

_____

_____

STEP NUMBER TWO

Prepare the necessary computer statements and submit your job to the computer.

STEP NUMBER THREE

Take the frequency distributions and the percentages from your computer printout and write them in the cells of the tables below. Be sure to include the marginals.

HYPOTHESIS NUMBER 1

VOTE ON ____ BY URBAN-RURAL INDEX

	URBAN	URBAN-SUBURBAN	SUBURBAN	SUBURBAN-RURAL	RURAL
YEA					
NAY					

HYPOTHESIS NUMBER 2

VOTE ON ____ BY URBAN-RURAL INDEX

	URBAN	URBAN-SUBURBAN	SUBURBAN	SUBURBAN-RURAL	RURAL
YEA					
NAY					

Do the differences in the most urban and the most rural districts tend to support or refute your hypothesis in the first table? What about the second table?

_____

_____

_____

_____

_____

_____

In order to evaluate these hypotheses it is important that the direction of the change from the most urban to the most rural categories be consistent in each of the intermediate categories. Applying this criterion, would you say that your hypotheses tend to be supported in each of the tables? Explain your conclusion.

_____

_____

_____

_____

_____

_____

On the basis of these two votes, what generalizations are you willing to make about the relationship between this constituency characteristic and the voting behavior of members of Congress? _____

_____

_____

_____

_____

_____

VIII. SELECTED BIBLIOGRAPHY

Anderson, Lee F., Watts, Meredith W. Jr., Wilcox, Allen R. *Legislative Roll-Call Analysis*. Evanston: Northwestern University Press, 1966. This book will be useful for students who have had prior training in political science methodology. The authors discuss techniques for doing roll-call analysis including clusterbloc analysis, Guttman scale analysis, and factor analysis.

Barone, Michael, Ujifusa, Grant, and Matthews, Douglas. *The Almanac of American Politics*. Boston: Gambit, Inc., 1973. Demographic and political information about the members of Congress and their constituencies. The almanac includes census and voting data of each of the Congressional districts and states, pictures and personal information about each of the Senators and Representatives, and selected roll-call votes and interest group ratings for each member of Congress.

Clausen, Aage R. *How Congressmen Decide: A Policy Focus*. New York: St. Martin's Press, 1973. A well-written analysis of the role of party, ideology, the President, and internal Congressional institutions and processes on policy formulation in five issue areas chosen by the author. An excellent critical essay on the conventional wisdom respecting constituency influence on members of Congress.

Clapp, Charles. *The Congressman: His Work as He Sees It*. New York: Anchor, 1964. Perhaps the best study ever done of the views of the Congressmen themselves on their own roles and responsibilities. The book is based on data gathered at the Brookings Institution during "round-table" discussion of a large number of members of the House of Representatives. Particularly valuable for those interested in comparing text assertions against actual practices in the House of Representatives.

Congressional Quarterly Weekly Reports. The best source of current and historical information about the Congress. The *Weekly Reports* and annual compilations (with very useful indices) include analysis of legislation and votes of all the members of the Congress, information about nomination and election of new and present members, status reports of pending legislation and committee activities, and ratings of members by interest associations.

Dexter, Lewis Anthony. *The Sociology and Politics of Congress*. Chicago: Rand McNally, 1969. A comprehensive treatment of the role of citizens as influences on legislative outcomes. The book is carefully organized for easy reading. The most useful material for this exercise is contained in two chapters that analyze constituency influences on voting choices of members of Congress. His chapter on "The Representative and His District" is particularly useful in enumerating the most common approaches and current explanations of this relationship.

Davidson, Roger H., Kovenock, David M., O'Leary, Michael K. *Congress in Crisis: Politics and Congressional Reform*. New York: Wadsworth, 1966. A data-based analysis of problems of and proposals for Congressional reform. The useful chapter for this exercise is number three, "Congressmen View Congress and Reform," in which the authors define the representatives' perceptions of their own roles in Congress and their associated attempts at representation.

Fiorina, Morris P., *Representatives, Roll Calls and Constituencies*. Lexington, D.C. Heath, 1974. An up-to-date, sophisticated analysis of relationships between certain constituency factors and congressional decision-making.

Froman, Lewis A. Jr. *Congressmen and Their Constituencies*. Chicago: Rand McNally & Co., 1963. An analysis of the effects of constituencies on voting decisions of members of Congress. Students will find chapter seven, "Constituency Differences Between Parties and Congressional Roll-Call Voting," and chapter nine "Competitiveness, Constituency Factors, and Roll-Call Votes," particularly useful reading for this exercise.

Kingdon, John W. *Congressman's Voting Decisions*. New York: Harper & Row, 1973. An analysis of institutions and processes important in Congressional decision-making. Students will find chapter two, "The Constituency" and chapter nine, "Decision Problems and Information," useful reading for this exercise.

MacRae, Duncan. *Dimensions of Congressional Voting*. Berkeley: University of California Press, 1958. This book will be particularly useful for students with some previous training in political science methodology. It is useful for its perceptive use of scale analysis of roll-call voting decisions of members of Congress.

Matthews, Donald. *U.S. Senators and Their World*. Chapel Hill: University of North Carolina Press, 1960. A well-written, interesting book that is principally a reflection of Matthews' extensive interviews with U.S. senators. Students will find the material on collegial exchange of information and advice giving particularly useful for this exercise.

Mayhew, David R. *Congress: The Electoral Connection*. New Haven, Yale University Press, 1974. An examination of representational theories in a contemporary context, supported by relevant congressional data.

Miller, Warren and Stokes, Donald. "Constituency Influence in Congress," *American Political Science Review* 57 (March, 1963), pp. 45-56. An exceptionally useful article for students doing this exercise. Miller and Stokes base their analysis on interviews with a random sample of

IX. CODEBOOK

Repeated here is an advisory note to students: a Yea vote on a bill does not always indicate support for the substance of that bill. Crucial votes are often cast on amendments, motions to send the bill back to committee, etc. We have therefore indicated both the substantive meaning of each vote in the Codebook and how many members of Congress voted Yea and Nay. You should keep this in mind when interpreting the Yea and Nay votes on your computer printout.

NOTE: In using this codebook, all OSIRIS users and SPSS users working with a SAVE FILE should ignore deck and column references. In these cases, all variables may be referenced by the variable identification number.

HOUSE OF REPRESENTATIVES DATA

VARIABLE NUMBER	COLUMN NUMBER	FREQUENCY	VARIABLE LABEL
VI	1		REGION OF COUNTRY
		25	0. New England
		80	1. Mid-Atlantic
		86	2. East-North Central
		35	3. West-North Central
		100	4. Solid South
		40	5. Border
		19	6. Mountain
		47	7. Pacific
		3	8. External
V2	5		SOUTH NON-SOUTH
		335	1. Non-South
		100	2. South
V3	6		URBAN-RURAL INDEX
		75	1. Urban
		82	2. Urban-Suburban
		90	3. Suburban
		81	4. Suburban-Rural
		107	5. Rural

VARIABLE NUMBER	COLUMN NUMBER	FREQUENCY	VARIABLE LABEL
V4	7		MEDIAN INCOME
		137	1. $5,000-$8,999
		158	2. $9,000-$10,999
		140	3. $11,000-$17,999
V5	8		% WITH INCOME OVER $15,000
		141	1. 5-14%
		148	2. 15-22%
		103	3. 23-34%
		45	4. 35-58%
V6	9		% WITH INCOME UNDER $3,000
		159	1. 0- 7%
		139	2. 8-11%
		82	3. 12-17%
		44	4. 18-33%
V7	10		MEDIAN YEARS OF SCHOOL
		54	1. 8-10 Years
		64	2. 11 Years
		269	3. 12 Years
		48	4. 13 Years
V8	11		% WITH WHITE COLLAR JOBS
		142	1. 30-42%
		139	2. 43-50%
		154	3. 51-79%
V9	12		WITH BLUE COLLAR JOBS
		139	1. 10-32%
		141	2. 33-39%
		155	3. 40-59%
V10	13		% WITH SERVICE JOBS
		119	1. 6-11%
		162	2. 12-13%
		154	3. 14-25%
VII	14		% FARMERS
		139	1. 0%
		208	2. 1-5%
		89	3. 6-24%

X. NOTE TO INSTRUCTORS

The criteria used in selecting variables suitable for introductory American government students doing empirically-based exercises were ease of definition, conceptualization and operationalization, and recency of congressional votes. District data apply to the districting for the 1972 election.

Exercise 1 calls for testing a bivariate hypothesis in which all students use the same independent variable (V3 Urban-Rural Index) and the same two dependent variables. So that students may compare variables associated at different levels, it is suggested that you assign one dependent variable from each of the following groups:

Group 1: V29 Military Economic Aid, V32 Urban Mass Transit, V34 Labor-HEW Appropriations, V36 Auto Emission Standards.

Group 2: V30 Alaska Pipeline, V31 Minimum Wage Increase, V33 War Powers Veto Override, V35 Trade Reform.

It is suggested that you run these tabulations yourself in advance, to clarify instructions for student runs, to check out the computer operation, and to prepare for class analysis. We have found it helpful to discuss the table with the stronger association first.

Exercise 2 calls for control by party, and it is useful to discuss the possible effects of party control before those tabulations are made.

Exercise 3 utilizes the interest group ratings. We recommend that the groups, their ideological and policy preferences and the implications of their ratings be discussed in class before each student selects his group. It is helpful if at least one student is responsible for each of the seven groups. Urban-rural, regional and party variables provide the strongest association with group ratings.

Exercises 1, 2 and 3 normally require about two weeks of class time to complete.

Exercise 4 introduces another dimension, presidential influence, and may serve as an optional exercise for those wishing to spend a third week. Advanced classes have data for more complex analysis. You may wish to supplement the data file by punching additional decks to include new members and current roll calls and group ratings.